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The Tabanidae of Tennessee

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Edited and designed by P.C. Mucke, Publications Editor, The University of Tennessee Agricultural Experiment Station Communications. The cover features a species of Tabanidae common in Tennessee, the horse fly *Tabanus trimaculatus*. Drawing by Susan J.M. Hope.

THE TABANIDAE OF TENNESSEE

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PART 1

The Tabanidae of Tennessee

INTRODUCTION

The family Tabanidae, commonly known as horse and deer flies, contains approximately 3800 species in 125 genera worldwide (L.L. Pechuman, personal communication). Their medium-to-large size and striking appearance as well as the blood-sucking habits of the females of most species have made these insects frequent targets of collectors. As a result, the adults are relatively well known taxonomically, especially in the Nearctic region.

The most recent catalog (Philip 1965) lists 292 species in 26 genera in America north of Mexico, but several additional species are now recognized. Keys dealing with major components of the known Nearctic fauna have been published by Brennan (1935), Stone (1938), and Philip (1955), and regional keys and lists of fauna are numerous. Keys and/or lists of Tabanidae from states near Tennessee may be found for Arkansas (Schwardt 1936), Georgia (Fattig 1946), Kentucky (Burnett et al. 1978), Missouri (Andrews and Wingo 1975), North Carolina (Brimley 1938, 1942; Wray 1950, 1967), South Carolina (Ezell et al. 1974), and Virginia (Pechuman 1973). An unpublished list of the Alabama fauna was provided by the late Dr. Kirby Hays (personal communication). This is the first attempt to collectively present available knowledge on Tennessee Tabanidae.

The first published record of species of Tabanidae from Tennessee (Osten Sacken 1876) noted the collection of *Tabanus nigrescens* near Knoxville and *T. sulcifrons* (as *T. tectus*). Although only four species of deer flies were reported from Tennessee by Brennan (1935) and Stone (1938) listed only a single species of horse fly from the state, the general distributions provided by these authors indicated that many additional species should be present. In his catalog of the Nearctic Tabanidae and its supplement, Philip (1947, 1950) listed 16 species known to inhabit Tennessee. Pechuman (1954) listed 26 species collected in Morgan County and provided data for their seasonal distributions. Snow et al. (1957) reported 51 species and 7 subspecies from the Tennessee Valley watershed. The unpublished checklist of the insects of the Great Smoky Mountains National Park included 12 species of Tabanidae from Tennessee, and the second known record of *Neochrysops globosus* was reported by Pechuman (1965). The above papers were summarized and 21 new state records and numerous county records were reported by Goodwin (1966, 1972, 1973a, 1973b, 1976a). Mullens and Gerhardt (1980) reported four state records, numerous county records, and seasonal distribution data and compared the tabanid faunal composition in different areas of eastern Tennessee.

This publication is based on both literature citations and recent unreported collecting activity. It should be noted that the range maps in the appendix tend to have records clumped in the eastern and western portions of the state. More often than not this reflects a paucity of collection data from the central Tennessee counties rather than a lack of tabanids. At present, 101 species, subspecies, and varieties have been reported from Tennessee; however, some are misidentified, as discussed later in this text. Species not yet discovered but likely to be in Tennessee are included in the keys. The authors also were supplied with detailed distributional data and collecting records gathered by Dr. L. L. Pechuman, Department of Entomology, Cornell University, Ithaca, New York. These records and subsequent discussions were invaluable, and the authors gratefully acknowledge Dr. Pechuman's generous assistance.

JUVENILE STAGES AND HABITS

Knowledge of the juvenile stages of horse and deer flies is meager in comparison with what is known of the adults, but the early stages of tabanids have been most thoroughly studied in the Nearctic Region. Teskey (1969) provided the most comprehensive treatment of the taxonomy and biology of the juvenile stages to date, and this work has been supplemented by several shorter papers.[1]

Tabanid eggs are laid in the spring or summer and have been found principally on the leaves or stems of aquatic vegetation. Often eggs are also found on other objects such as stones and logs near aquatic areas (Tidwell and Hays 1971; Foster et al. 1973). Eggs of the more terrestrial species rarely are found and generally are associated with lower leaves or branches of small plants and trees. Eggs are laid in masses of 100 to 500 and may be in one or several tiers. A few species (e.g., *Atylotus thoracicus*) may lay eggs singly (Mullens et al. 1983). The single tier arrangement may consist of eggs attached to the substrate by their tips (many *Chrysops*, some *Tabanus*, and *Goniops chrysocomus*) or along their whole length (some *Chrysops*). Egg masses with two or more layers are usually laid by a few *Chrysops*, most *Tabanus*, *Hybomitra*, and *Merycomyia*. When first laid, the eggs are whitish, but they typically darken to shades of brown or black before hatching several days after oviposition (Figures 1 and 2).

The larvae of most species have been found in moist areas ranging from saturated mud on lake bottoms to less moist areas along shorelines. Other habitats include rotten logs and tree holes. While most tabanids are considered aquatic or semi-aquatic, certain species, such as *T. sulcifrons*, have been found in drier soil (Schomberg 1952). Some others, such as

[1]See Burger 1977; Goodwin 1972, 1973a, 1973b, 1974, 1976a, 1976c, 1986; Lane 1975, 1976, 1979; Teskey 1985; Teskey and Burger 1976; Tidwell 1973; and Tidwell and Tidwell 1973.

Figure 1. Female *Tabanus* laying eggs on a plant stem. The eggs are whitish and attached only at one end.

Figure 2. Typical arrangement of *Chrysops* sp. (probably *callidus*) eggs on the leaf blade of a semi-aquatic plant.

T. fairchildi, are found in fast moving streams. Many species are typically associated with a certain substrate, but some, such as *T. subsimilis*, occur in a wide range of soil habitats (Thompson 1975).

Except for the larvae of *Goniops*, which are club shaped, Tennessee tabanid larvae are morphologically similar. Most are whitish (sometimes shades of brown or green) and spindle shaped, being widest near the middle and tapered at both ends (Figure 3). The degree of tapering varies and, although of some taxonomic use, seems to reflect type of habitat. Larvae of species occurring in dry or sandy soil conditions are often blunt in form, while greatly tapered larvae are more typical of very moist habitats. Andreyeva (1982) divided tabanid larvae into three basic morphological groups: (1) rheophilus and subrheophilus (aquatic with an elongated body and well-developed pseudopods), (2) hemi-hydrobiont (typically live in marshy soils), and (3) edaphobiont (terrestrial with a squat body and very short pseudopods). Patterns of microscopic hairs and/or scales on the larval cuticle, the shape of the posterior respiratory siphon, and the rings of pseudopodia on the abdominal segments are very important in larval identifications.

Tabanid larvae are considered to be predaceous on various soil invertebrates such as earthworms and soft-bodied dipteran larvae. Many, especially the larvae of horse flies (Tabaninae), are also cannibalistic. *Chrysops* larvae are thought to feed on vegetable material and apparently are not as cannibalistic as tabanine larvae, although some have been observed feeding on dipteran larvae in captivity (Logothetis and Schwardt 1948; Goodwin, personal observation). In addition, Goodwin (1982) reported a case of cannibalism by *Chrysops* observed in the laboratory.

The larvae undergo from 6 to 13 molts, overwinter in that stage, and move to slightly drier soil to pupate the following spring or summer. Pupae are generally brown or straw-colored, but may be green or blackish. Rings of spines circle the posterior third of most abdominal segments. At the posterior end is a pupal aster formed of three (occasionally two) pairs of stout, pointed, divergent projections. Characteristics of the adults, such as the large eyes and frontal features, are often visible through the cuticle several days before eclosion. Pupal periods vary from 4 to 21 days and depend on the species and temperature.

The majority of Tennessee species probably have a single generation per year, but there is evidence of a partial second brood in a few species (Mullens and Gerhardt 1980). Some of the very large species such as *T. atratus* may require two or even three years to complete a life cycle (Schwardt 1932).

ADULT HABITS

Adult males tend to emerge slightly in advance of the females. Males often hover in the morning hours or rest on vegetation and wait for females to pass by. Mating appears to take place in flight. The sex ratio at emergence is about 1:1. Hovering and mating are discussed by Bailey (1948), Blickle (1959), and Catts and Olkowski (1972). Wilkerson et al. (1985) have recently reviewed this aspect of behavior.

Females of most Tennessee tabanid species require a blood meal for the first gonotrophic cycle and may produce further batches of eggs with subsequent blood meals. Autogeny, the ability to mature eggs without taking a blood meal, is a known trait of some tabanids (Thomas 1972). The females of many tabanid species tend to attack specific areas of a host animal's body when seeking a blood meal (Mullens and Gerhardt 1979), but the reasons for this behavior are poorly understood. Factors relating to the attraction of blood-seeking females to their host are discussed in the section on collecting methods. Males and some females feed on pollen and nectar (Roberts 1967; Wilson and Lieux 1972; Magnarelli and Anderson 1981).

Members of both sexes of some tabanid species can be observed flying low over pools and streams and occasionally touching the water surface. Resting adults are sometimes seen on the moist mud around such areas and have also been found resting in low trees and bushes (Okiwelu 1977). In addition, dirt paths and the edges of woods apparently may serve as natural flyways and patrolling areas for hovering males.

Tabanids fly well and may disperse 1 to 2 km from their breeding sites, although most do not fly far (Thornhill and Hays 1972). Sheppard and Wilson (1976) recaptured *T. lineola*

up to 6.8 km from their release point.[2] Most tabanids are diurnal, some are crepuscular or nocturnal, and many show definite activity patterns (Roberts 1974; Burnett and Hays 1977). These activity patterns have been related to various meteorological factors, notably barometric pressure and temperature (Alverson and Noblet 1977; Burnett and Hays 1974; Schulze et al. 1975).

Studies on tabanid biology have been hampered by their long life cycle, predaceous and cannibalistic larval habits, and the reluctance of adults to feed and their refusal to mate in captivity. Recent workers (e.g., Thompson et al. 1979) have succeeded in developing satisfactory blood-feeding and/or rearing systems for a few tabanid species, but mating remains a major obstacle in establishing a laboratory colony for any tabanid species.

NATURAL ENEMIES

Numerous accounts of natural enemies of various tabanid stages have been published, but the impact of these agents on tabanid population levels is unknown. Jenkins (1964) provided a list of predators, parasites, and pathogens of Tabanidae. Poinar (1985) recently reviewed nematode parasites and pathogens.

Egg parasites include wasps in the families Trichogrammatidae and Scelionidae (Stone 1953; Dukes and Hays 1971). Predators of tabanid eggs, such as lady beetles, were discussed by Jackson and Wilson (1965). Parman (1928) reported using egg parasites to reduce horse fly population levels in Texas.

Larvae are parasitized primarily by dipterans in the families Tachinidae and Bombyliidae (Goodwin 1968; Teskey 1969), but the incidence of parasitism is usually low. A low incidence of pupal parasitism due to hymenopterans in the families Diapriidae and Pteromalidae has also been reported (Goodwin 1968; Teskey 1969). Burger et al. (1981) reported high levels of pupal parasitism by the pteromalid *Diglochis occidentalis* (Ashmead) in certain *Chrysops* populations in New Hampshire. Larval predators include fish, shore birds, etc. (Johnson and Hays 1973). An unknown amount of larval mortality also results from predation or cannibalism within the family Tabanidae itself, especially in the genera *Tabanus* and *Hybomitra*.

Adults are sometimes parasitized by sarcophagid flies (Thompson 1978a), and adult predators include asilids, spiders, dragonflies, and birds. Bembicine wasps, such as the "horse guard," *Strictia carolina* (Fabricius), frequently provision their nests with tabanids (Roberts and Wilson 1967).

Pathogens of Tabanidae, mostly fungi, are presented by Anthony (1977) and Poinar (1985). Relatively few bacteria, fungi, or protozoa have been recovered from tabanids, and no viruses or rickettsia are known from these hosts to date.

ECONOMIC IMPORTANCE AND CONTROL

The vicious biting habits of female tabanids can make them very annoying to both man and livestock. Outdoor industry and recreation may be hampered, especially when *Chrysops* populations are high. This biting fly activity may lead to loss of revenue and lowered property values in some cases (Gerhardt et al. 1973).

Pastured cattle and other livestock may suffer severely from heavy attacks of tabanids, and nervous activity may supplant normal grazing. Tashiro and Schwardt (1949) estimated that 40 *T. sulcifrons* would cause a cow to lose 115 cc of blood in 1 hour. Hollander and Wright (1980) estimated a total blood loss of 200 cc/day in Oklahoma and that only approximately 10 percent of landing tabanids succeeded in obtaining a blood meal. They stated that the actual loss may be greater because the wounds often continue bleeding after feeding has ceased (Figure 4). Feeding success was shown to vary significantly among species. Dense fly populations are thought to contribute to slower weight gain and lower milk production in cattle (Bruce and Decker 1951; Granett and Hansens 1957), and blood oozing from the wound inflicted by tabanids may be fed upon by other flies (Garcia and Radovsky 1962) thus increasing the risk of infection. Perich et al. (1986) demonstrated that beef cattle exposed to an average of 66-90 horse flies per animal per day gained 0.08-0.10 kg per day less than protected cattle, and feed efficiency decreased 16.9 percent. Steelman (1976) discussed the need for further studies to determine the economic impact of tabanids on livestock.

[2]Editor's note: While this manuscript was in production, Cooksey and Wright reported recapturing an average of 6 percent of marked, released *T. abactor*, most within 0.8 km of the release site. Blood-engorged females were recaptured 3-4 days post-release (the length of the gonotrophic cycle). The researchers felt that dispersal occurred in a series of short flights—L.M. Cooksey and R.E. Wright (1987): Flight range and dispersal activity of the host-seeking horse fly, *Tabanus abactor* (Diptera: Tabanidae), in north central Oklahoma. Environ. Entomol. 16:211-17.

Figure 3. Mature larva of *Tabanus atratus*.

Figure 4. Female *Tabanus sulcifrons* feeding on the back of a cow.

Many reports have been published relative to the transmission of disease organisms by horse flies and deer flies (Krinsky 1976). Tabanids often are disturbed while feeding but rapidly return to the same or a different host if feeding has not been completed. Foil (1983) estimated that 95 percent of tabanids would return to the original host (in this study, a horse) to continue feeding, provided other hosts were at least 40 meters away; he commented on the relevance of this finding to reducing mechanical transmission of equine infectious anemia. If disease organisms are present in the blood of the initial host, they may be carried on the mouthparts of the fly and enter another host as the fly feeds. Disease organisms sometimes mechanically transmitted by tabanids include viruses (equine infectious anemia, hog cholera, California encephalitis, and vesicular stomatitis), bacteria (anthrax and tularemia), rickettsia or related forms (Q-fever and anaplasmosis), and certain trypanosomes. In biological transmission, the disease organism undergoes development and/or propagation in the insect vector. This occurs with the filarial worms *Loa loa* (African eye worm) and *Elaeophora schneideri*, a pathogen of elk and domestic sheep in the southwestern United States, as well as with *Trypanosoma theileri,* a nonpathogenic protozoan of cattle and sheep (Krinsky 1976).

Prospects for control of tabanids are not particularly good, due to the large number of species present in an area, their varying biological characteristics and seasonal distribution, and the short time the flies spend on their hosts. Anderson (1985) reviewed control prospects for this group. Chemical applications to livestock may be of limited use for short-term control (Bay et al. 1976; Blume et al. 1971; Brown and Lancaster 1973; Harris and Oehler 1977). Area-wide chemical applications for adult control can be temporarily effective if timed properly (Hansens 1981), but are usually less effective for tabanids than are similar applications for mosquitoes (Axtell and Dukes 1974). Insect repellents in aerosol or impregnated mesh shirts offer temporary relief from deer fly annoyance for humans (Catts 1968; Gilbert 1957). Chemical control of larvae (Wall and Marganian 1973) may lead to the destruction of nontarget organisms and the disruption of ecosystems.

Water management has been used for control of tabanids (Anderson and Kneen 1969), though such manipulation may not be possible or desirable in many areas. Trapping devices are ecologically attractive and catch large numbers of tabanids, but with the possible exception of large-scale efforts in coastal areas (Wall and Doane 1980), their effectiveness in suppressing tabanid populations over time has not been well documented. Wilson (1968) caught over 95,000 tabanids in 5 days on 20 CO_2-baited sticky traps around a cow pasture, but noted only short-term reductions in horse fly levels on cattle.

Under heavy tabanid attack, animals often seek shelter in dense vegetation, water, or man-made enclosures. Grouping behavior may also be defensive, as Duncan and Vigne (1979) observed that horses in large groups were attacked less than those in small groups. A barn or shed may allow the animals to avoid the flies, but the loss of grazing time may negate any beneficial effect.

The potential use of predators, parasites, and pathogens as biological control agents has not been examined in any detail and further studies are needed.

COLLECTION, HANDLING, AND PRESERVATION

Juvenile Stages

Since this presentation is devoted primarily to adult Tabanidae, detailed methodology for working with juvenile stages is not included, but methods are discussed by Burger (1977), Goodwin and Murdock (1974), Lane (1975, 1976), Teskey (1969), and Tidwell (1973). Removal of larvae from their substrate may be difficult, and various washing or drying racks to assist in this have been devised (Edwards et al. 1974; Lane and Anderson 1976; Tashiro and Schwardt 1949; Teskey 1962). If living larvae are obtained, rearing may yield excellent adult specimens, and larval and pupal skins may be recovered for taxonomic study. If preservation is necessary, it is best to kill the larva or pupa in 80-85°C water and preserve the specimen in 70 percent ethyl alcohol. Isopropyl alcohol, but not formalin, also may be used. Label information should include locality, date, collector, preservative, and habitat medium in which the juvenile was found.

Adults

Some methods of collecting adult tabanids were reviewed by Thompson (1969) and Roberts (1978). The standard aerial net has been the most commonly used tool. Swinging the net in a circular fashion about the head and body while walking along woodland paths, streams, etc. usually will yield excellent series of species that attack man. The use of a bait animal, such as a steer, often will attract females of many tabanid species that can be netted.

Males and nonblood-feeding females are more difficult to collect, but can be obtained by sweeping flowers and vegetation, by rearing immatures, or by certain flight-interception traps. Kniepert (1979) used a piece of shiny, black plastic to attract male tabanids who apparently mistook it for a pool of water, the flies were netted as they dipped toward or landed on the surface.

Various traps have been widely used to survey fly seasonal distribution and relative abundance, although Mullens and Gerhardt (1979) caution that different trap types may have inherent biases in their catch due to the characteristic attack patterns of the different species. Roberts (1976b) examined the relative efficiency of some of the most commonly used trap types for collecting tabanids and found CO_2-baited Malaise and canopy traps to be most effective. Malaise traps (Malaise 1937) will capture both males and females (Figure 5), and are described in publications by Burnett and Hays (1977), Gressitt and Gressitt (1962), Roberts (1972), Townes (1962), and others. Sticky traps (Dale and Axtell 1976; Roth and Lindquist 1948; Snoddy 1970) have been used by some workers to capture large numbers of tabanids, but specimens often are hard to identify and require a solvent to remove the adhesive (Figure 6). Steelman et al. (1968) designed a trap that is carried atop a truck or boat and sweeps flying tabanids into a collecting bag. Emergence traps also have been used (Macreary 1940; Rockel and Hansens 1970).

Roberts (1965) used a steer-baited trap similar to the Magoon trap (Magoon 1935) to collect female tabanids. The box trap (Morris and Morris 1949), originally used in Africa for tsetse fly studies, has been adapted and used in the United States for tabanids, especially in coastal areas (Dale and Axtell 1976; Granger 1970; Hansens et al. 1971). Manitoba or

Figure 5. A Malaise trap equipped with a black beach ball as a target for added attractiveness to adult female Tabanidae.

Figure 6. Gerhardt (left) and Mullens (right) examine one of many sticky traps used to sample tabanids at various study sites in Tennessee.

Figure 7. A Manitoba canopy trap at the Ball Play site was used to determine seasonal abundance.

canopy traps (Thorsteinson et al. 1965) date from Thorsteinson's original heliothermal trap (1958), and some variations (Figure 7) are described in publications by Adkins et al. (1972), Axtell et al. (1975), Catts (1970), and Pechuman (1972).

Other methods of obtaining adults include the use of light traps (Anthony 1960; Frost 1953), food baits (Frost 1953; Jones and Anthony 1964), examination of spider webs and window sills, and searching solitary wasp nests.

Factors that influence tabanid attraction have been widely studied but are still not entirely clear. Numerous workers have shown that CO_2 is attractive to female tabanids (Anderson et al. 1974; DeFoliart and Morris 1967; Knox and Hays 1972; Roberts 1971; Wilson et al. 1966), but too much actually may decrease trap catches (Roberts 1975). Trap or host color has an influence, and dark colors are generally favored for attack (Bracken et al. 1962; Tashiro and Schwardt 1953). Roberts (1970) and Bracken et al. (1962) observed that contrast with the background was also important. Decoy shape (Thorsteinson et al. 1966) and pattern (Hansens et al. 1971) may also affect trap catches. Other factors include height (Roberts 1976a), motion (Bracken et al. 1962; Phelps and Vale 1976), and possibly heat (Thorsteinson 1958). Browne and Bennett (1980) reported blue, black, and red as preferred colors and found no preference for moving versus stationary decoys.

Collecting activity is most productive near breeding areas such as ponds or marshes or along natural flyways such as forest-field edges, streams, or roads in woods. Regardless of method of collection, specimens should be pinned fresh with collecting data, including locality, date, collector, and other pertinent information on the pin. If the circumstances are such that specimens must be stored unpinned, liquid preservatives should not be used. Dried specimens may be placed in single layers, none touching the other, with layers separated by dry tissue paper. Cotton should not be used as it becomes entangled in appendages and may damage the specimen when removed. The dry specimens can be relaxed later and pinned, as mentioned in most general entomology textbooks. Specimens can also be frozen fresh, again in layers with none touching, but they should be pinned very soon after removal from the freezer. Dirty or greasy specimens can usually be cleaned satisfactorily by immersion in ethyl acetate for a few hours.

CLASSIFICATION

The current suprageneric classification is based largely on the work of Mackerras (1954, 1955a, 1955b). Fairchild (1969) discussed the classification of the neotropical fauna and shifted the genus *Leucotabanus* from the tribe Tabanini to the Diachlorini, but otherwise his presentation did not affect the fauna of Tennessee. Classification of the North American fauna has been most recently treated by Philip (1957, 1965). Names used here are based on the latter paper except for species described subsequently and where more recent nomenclatural changes are applicable.

The family is comprised of three subfamilies each with three principal tribes. The subfamilies, tribes, genera, and number of species per genus found in Tennessee are presented in Table 1. Numbers appearing in parentheses represent the estimated maximum number of species that may occur in the state.

Table 1. The subfamilies, tribes and genera of Tabanidae represented in Tennessee

Taxa	Number of Species†
Subfamily Chrysopsinae	
Tribe Bouvieromyiini	
Genus *Merycomyia*	1
Tribe Chrysopsini	
Genus *Chrysops*	29(35)
Genus *Neochrysops*	1
Genus *Silvius*	1
Subfamily Pangoniinae	
Tribe Pangoniini	
Genus *Stonemyia*	3
Tribe Scionini	
Genus *Goniops*	1
Subfamily Tabaninae	
Tribe Diachlorini	
Genus *Diachlorus*	1
Genus *Chlorotabanus*	1
Genus *Leucotabanus*	1
Tribe Haematopotini	
Genus *Haematopota*	1
Tribe Tabanini	
Genus *Atylotus*	2(3)
Genus *Hamatabanus*	1
Genus *Hybomitra*	6(10)
Genus *Tabanus*	45(48)
Genus *Whitneyomia*	1
Total	**95(109)**

†This column lists the number of species of a genus actually collected in the state. The numbers in parentheses represent the number of species collected plus those species likely to be found in the state.

The totals in Table 1 do not include six species—*Stonemyia fera* (Williston), *Chrysops mitis* Osten Sacken, *Chrysops sackeni* Hine, *Chrysops striatus* Osten Sacken, *Tabanus cayensis* Fairchild, and *Atylotus thoracicus* (Hine)—each of which has been reported in Tennessee by previous authors. We have decided to remove these species from the state list for these reasons:

Stonemyia fera. Philip (1950) reported *S. tranquilla fera* from Tennessee. We have followed the view of Pechuman (1972) that there are two species, the western *S. fera* and the eastern *S. tranquilla*; hence, the Tennessee specimens are considered to be the latter.

Chrysops mitis. This species is included in the Tennessee fauna in the unpublished checklist of the insects of the Great Smoky Mountains National Park. The specimens on which the record is based were actually *C. cincticornis*.

Chrysops sackeni. Philip (1947) reported this species from Tennessee but provided no locality information. No additional specimens have been collected, and since in the southern states it is known only east of the Appalachian Mountains, we feel that it should be removed from the state list.

Chrysops striatus. Snow et al. (1957) and Goodwin (1966) reported this species from Tennessee. A reexamination of the available specimens indicates that they are actually *C. vittatus*. In addition, *C. striatus* is a northern species with the presently known southern limit of its range in Pennsylvania.

Tabanus cayensis. Philip (1947) reported this species from Tennessee. Excluding the Tennessee specimen, the species is known only in southern Florida. It seems, since the specimen in question has not been confirmed as *T. cayensis*, that the specimen is incorrectly labeled.

Atylotus thoracicus. This name is listed by Goodwin (1966) and Mullens and Gerhardt (1980) and should be deleted from the state list because it was based on incorrect identifications. (See comments later in text under *A. duplex* and *A. ohioensis.*)

TAXONOMIC CHARACTERS

Juvenile Stages

Generic keys are provided for the identification of the larvae and pupae, but keys for the identification of species are not included. Figure 8 (page 8) should facilitate the use of the generic keys that illustrate those characters commonly used in descriptive work on the juvenile stages. Excluding the genera of the tribe Tabanini, the known larvae and pupae of the Tennessee fauna have characters that readily facilitate identification at the generic level. Separation of most of the genera of the Tabanini and species identification are more difficult. However, since the larvae and pupae of a great many species are known, Table 2 is presented to aid those seeking more detailed taxonomic information. In this table are listed all Tennessee species for which published descriptions of larvae and/or pupae are available; citations to the pertinent literature are given.

Adults

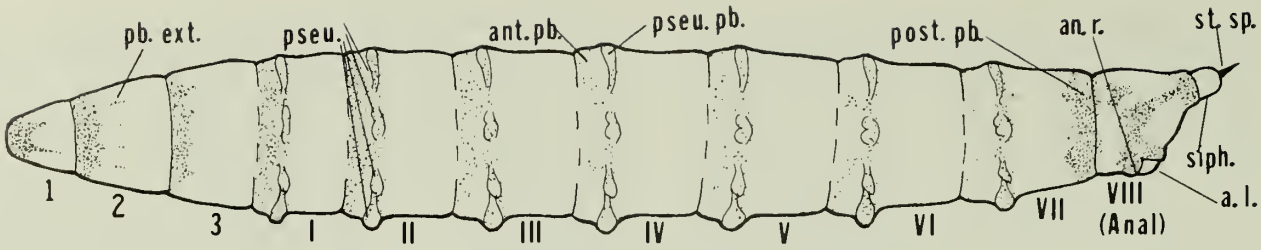
In the Tabanidae, useful structural characters are few and limited primarily to the head and its appendages. For this reason, the color and pattern of the body and its appendages play a major role in identification of species. This is especially true for the sexually dimorphic males, which lack most of the useful structural characters of the female head. Consequently, separate keys for the males are necessary for the larger genera like *Chrysops, Hybomitra,* and *Tabanus.* Since color and pattern play such an important role in species identification, caution must be used when examining specimens lacking part or all of its appendages such as antennae and palps. Access to a comparative collection is extremely helpful. Newer taxonomic methods, such as electrophoresis (Hudson and Teskey 1976) are now helping to supplement traditional taxonomic methods. Figure 9 (page 9) illustrates most of the characters used in the keys.

Table 2. List of species for which descriptions and/or keys are available for immature stages

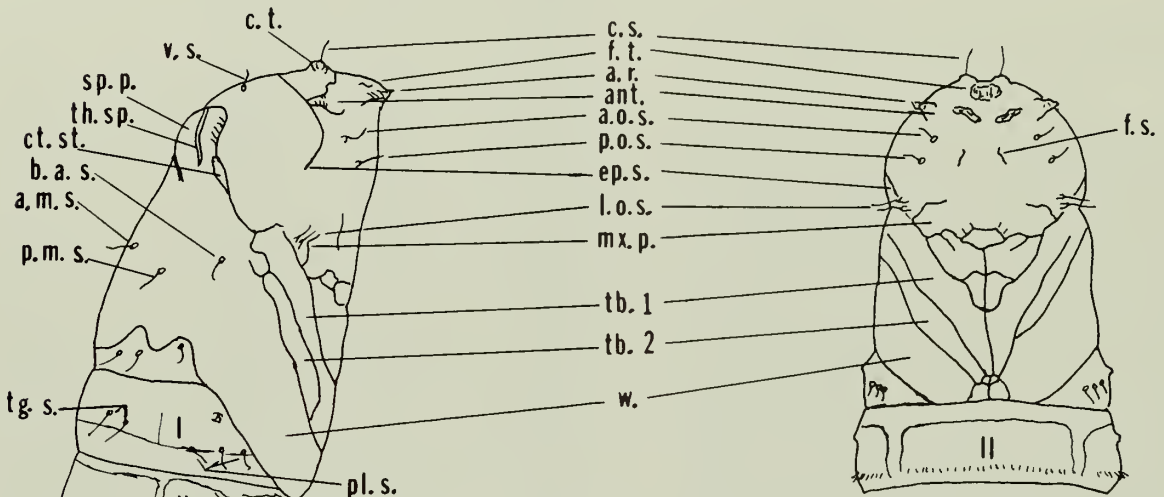
Species	Reference(s)†	Species	Reference(s)†
Atylotus		***Leucotabanus***	
bicolor	8	*annulatus*	3, 10
ohioensis	8	***Merycomyia***	
duplex	8	*whitneyi*	8, 10
Chlorotabanus		***Silvius***	
crepuscularis	3, 10	*quadrivittatus*	1
Chrysops		***Tabanus***	
brimleyi	8, 10	*americanus*	10
brunneus	5	*aranti*	4, 10
callidus	8, 10	*atratus*	8, 10
calvus	8	*calens*	8
carbonarius	8	*cymatophorus*	7
celatus	8, 10	*fairchildi*	8, 10
c. cincticornis	8, 10	*fulvulus*	11
cuclux	8	*gladiator*	4
dimmocki	8, 10	*imitans*	6
flavidus	8, 10	*lineola*	8, 10
geminatus	8	*marginalis*	8
indus	8	*melanocerus*	8, 10
macquarti	8	*molestus*	10
moechus	8	*mularis*	11
montanus	8	*nigrescens*	4, 10
niger	8, 10	*nigripes*	8, 10
nigribimbo	8, 10	*limbatinevris*	4, 8
o. obsoletus	7	*novascotiae*	9
parvulus	8	*pallidescens*	11
pikei	8, 10	*petiolatus*	8, 10
pudicus	5*	*proximus*	10
reicherti	2, 10	*pumilus*	8, 10
sequax	9	*quinquevittatus*	8
shermani	8	*reinwardtii*	8, 10
upsilon	10	*sackeni*	6
univittatus	8, 10	*similis*	8
vittatus	8, 10	*sparus milleri*	8
Diachlorus		*stygius*	8, 10
ferrugatus	3	*s. subsimilis*	4
Goniops		*sulcifrons*	8, 10
chrysocomus	8	*superjumentarius*	8
Hybomitra		*trimaculatus*	4, 10
cincta	6*, 9	*venustus*	6, 7
lasiophthalma	8	*wiedemanni*	9
microcephala	9	*wilsoni*	11
minuscula	8	*zythicolor*	7*
pechumani	8	***Whitneyomyia***	
sodalis	12	*beatifica*	6
typhus	8		

†REFERENCE CODE: 1, Burger 1977; 2, Goodwin 1972; 3, Goodwin 1973a; 4, Goodwin 1973b; 5, Goodwin 1976a; 6, Goodwin 1976c; 7, Goodwin 1986; 8, Teskey 1969; 9, Teskey and Burger 1976; 10, Tidwell 1973; 11, Tidwell and Tidwell 1973; 12, Teskey and Thomas 1979.

*Description includes only the pupa.

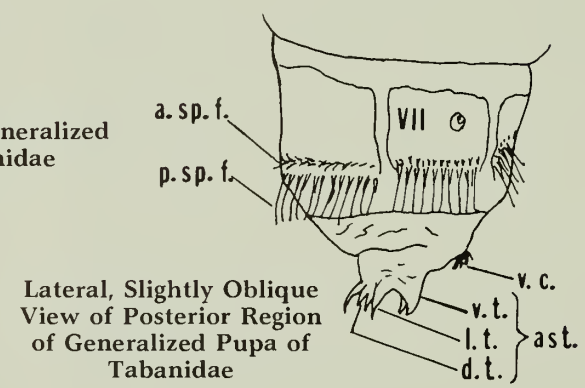


Lateral View of Generalized Larva of Tabanidae



Lateral View of Generalized Pupa of Tabanidae

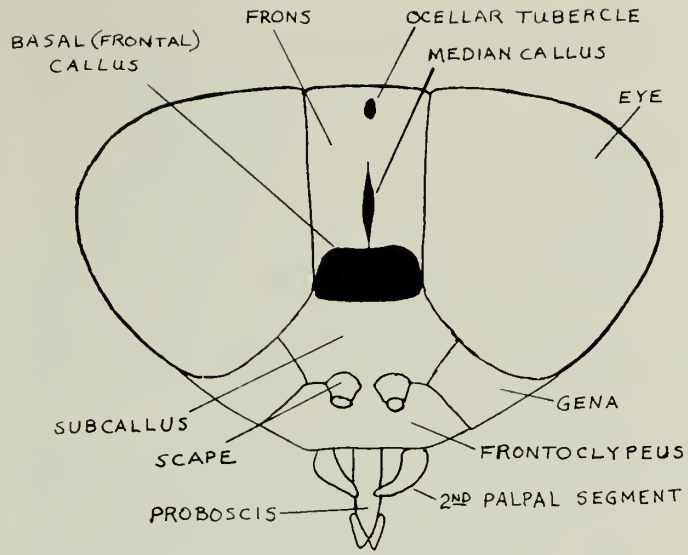
Ventral View of Anterior ½ of Generalized Pupa of Tabanidae



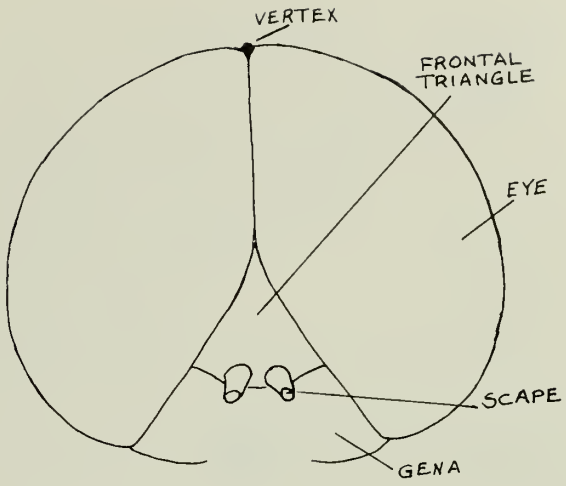
Lateral, Slightly Oblique View of Posterior Region of Generalized Pupa of Tabanidae

LARVAL ABBREVIATIONS: *a.l.*, anal lobe; *an.r.*, anal ridge; *ant. pb.*, anterior pubescence; *pb. ext.*, pubescent extension; *post. pb.*, posterior pubescence; *pseu.*, pseudopodia; *pseu. pb.*, pseudopodial pubescence; *siph.*, siphon; *st. sp.*, stigmatal spine; 1-3, thoracic segments; I-VIII, abdominal segments. PUPAL ABBREVIATIONS: *a.m.s.*, anterior metanotal seta; *a.o.s.*, anterior orbital seta; *a.r.*, antennal ridge; *a.sp.*, abdominal spiracle; *a.sp.f.*, anterior spinous fringe; *a.t.*, anal tubercle; *ant.*, antennal sheath; *ast.*, aster; *b.a.s.*, basal alar seta; *c.s.*, callus seta; *c.t.*, callus tubercle; *ct.st.*, cephalothoracic suture; *d.c.*, dorsal comb; *d.t.*, dorsal tubercle; *ep.s.*, epicranial suture; *f.s.*, frontal suture; *f.t.*, frontal tubercle; *l.c.*, lateral comb; *l.o.s.*, lateral orbital seta; *l.t.*, lateral tubercle; *mx.p.*, maxillary palp; *p.m.s.*, posterior metanotal seta; *p.o.s.*, posterior orbital seta; *p.sp.f.*, posterior spinous fringe; *pl.*, pleuron; *pl.s.*, pleural setae; *sp.f.*, spinous fringe; *sp.p.*, spiracular prominence; *st.*, sternite; *tb. 1*, tibia #1; *tb. 2*, tibia #2; *tg.*, tergites; *tg.s.*, tergal setae; *th.sp.*, thoracic spiracle; *v.c.*, ventral comb; *v.s.*, vertical seta; *v.t.*, ventral tubercle; w., wing; *I-VII*, abdominal segments.

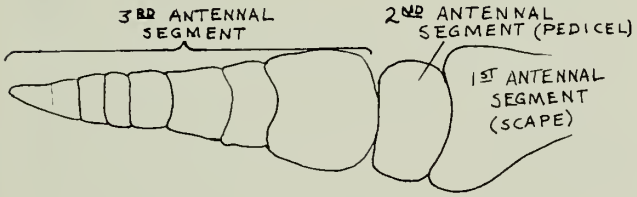
Figure 8. Details of the external morphology of a generalized larva and pupa of Tabanidae.
(Redrawn by Goodwin from several sources.)



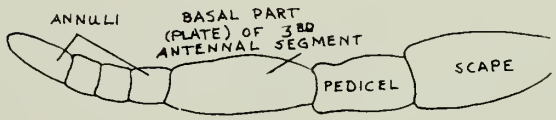
a. Generalized female head of Tabanidae



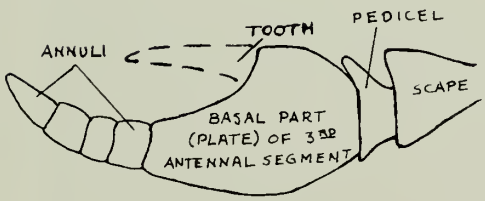
b. Generalized male head of Tabanidae



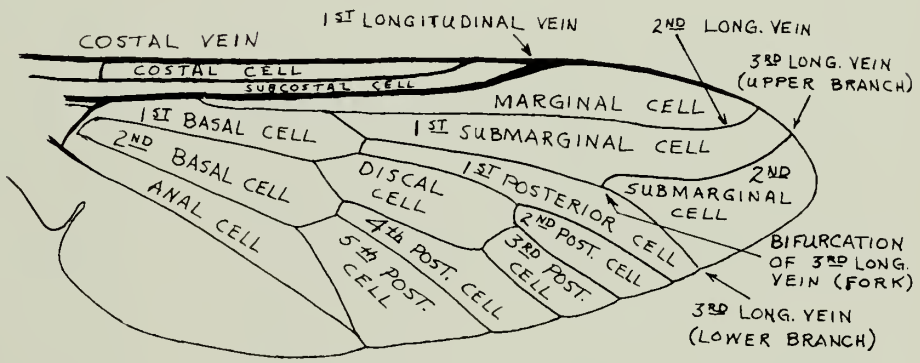
c. Generalized pangoniine antenna



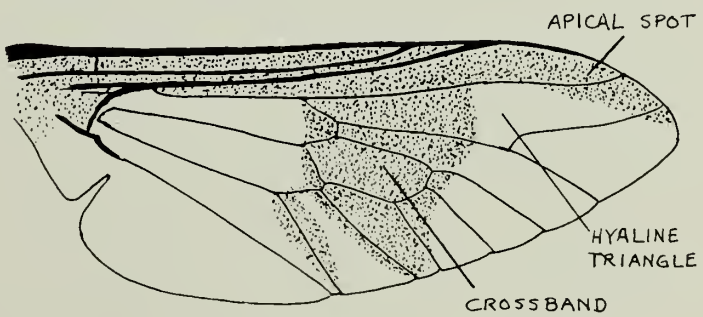
d. Generalized chrysopsine antenna



e. Generalized tabanine antenna



f. Generalized wing of Tabanidae



g. Generalized wing of genus *Chrysops*

Figure 9. Details of the head, wings, and antennae of horse flies and deer flies emphasizing the characteristics used in the adult keys. (Redrawn by Goodwin from several sources.)

ZOOGEOGRAPHICAL ZONES OF TENNESSEE

Environmental factors such as temperature, rainfall, and atmospheric moisture are important determiners of the presence and abundance of insects, including tabanids. These factors interact with topographic features and result in specific vegetation types, which in turn influence the microclimate. Human activity, such as the building of reservoirs and roads, the draining of marshes and swamps, and agriculture and forestry practices can also influence tabanid occurrence and abundance.

Tennessee has extensive east to west physiographic variation (Figure 10), and corresponding vegetative cover types are also quite diverse (Figure 11). There are eight physiographic regions in the state. They all generally extend from north to south with the corresponding temperature difference that results from 100 miles of latitude. This temperature difference is usually not as great as the difference among physiographic regions.

In the eastern part of the state three regions are part of the Southern Appalachian Mountains. In the far east are the Unaka Mountains. These mountains are characterized by high rainfall, steep and rugged topography, and dense vegetation. The elevation ranges from 1000 feet in the valleys and coves to 6642 feet at Clingman's Dome. The vegetative types are quite diverse and often unique in the southeastern United States. Most of the mountains are covered with Appalachian oak forest with various species of *Quercus* predominant. Along the Tennessee-North Carolina border four discrete pockets of Northern hardwoods represent the southernmost extension of northern boreal forests. The high rainfall, large changes in elevation, and mixture of northern and southern forests make the Unaka Mountains the most diverse assemblage of plants and animals to be found north of the neotropical rainforests.

To the west of the Unaka Mountains is the Valley and Ridge region, characterized by ridges with broader valleys that extend in a general northeast-southwest direction. The elevation of the valleys decreases from 1000 feet in the Bristol area to 750 feet in the Chattanooga area. The ridges range from about 1500 to 3100 feet in elevation. The predominant forest is Appalachian oak forest. Substantial areas of the Valley and Ridge region have been cleared for agriculture. Tobacco, corn, soybeans, and beef and dairy cattle are the predominant commodities. On cattle farms there are numerous ponds, which are excellent tabanid habitats that would not otherwise exist in the absence of agriculture.

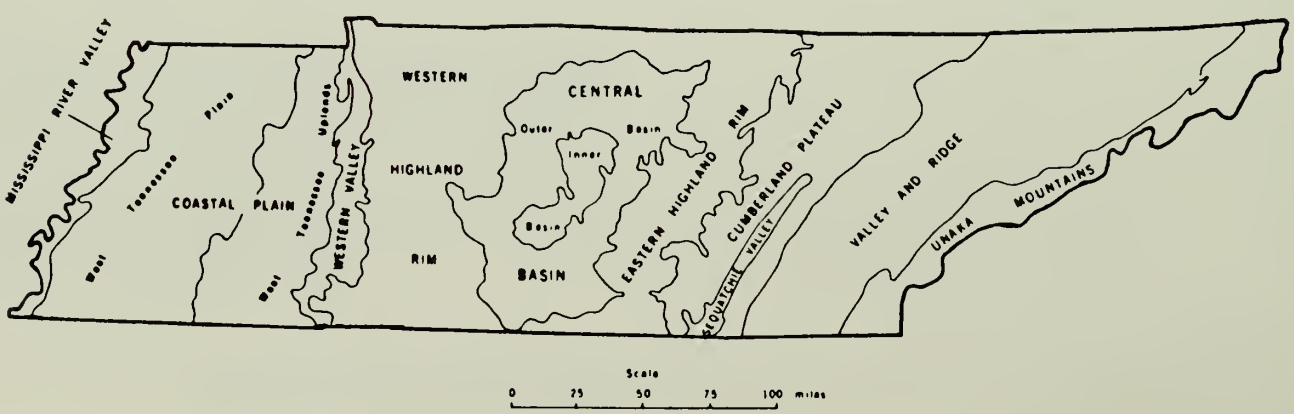
Immediately west of the Valley and Ridge region is the Cumberland Plateau, the southernmost portion of the larger Appalachian Plateau. The eastern border of the plateau is a very steep escarpment that averages 900 feet in height. The plateau is relatively flat and between 1700 and 1900 feet above sea level. There are some mountains, numerous deep gorges, and two major valleys, the Sequatchie in the south and the Elk in the north. The predominant vegetative type is mixed mesophytic forest, which extends north through Kentucky and into Ohio and Pennsylvania.

The Highland Rim in the central portion of the state extends from the Cumberland Plateau to the Western Tennessee River Valley and surrounds the Central Basin. In the east, the rim has fairly level ground, but its western portion is more rolling. The predominant forest type is oak-hickory (*Quercus* and *Carya*); it extends north into Kentucky, Illinois, Indiana, and southern Michigan. There are several areas along the Kentucky border that are mixed bluestem prairie and oak-hickory forest. This is the southernmost extension of a type of vegetation that is common in Illinois, Iowa, Missouri, and Oklahoma. The general elevation of the Highland Rim is 1000 feet.

The Central Basin is a depressed area in the middle of the Highland Rim; its outer elevation is about 750 feet and its flatter inner portion is about 600 feet above sea level. The inner portion is fairly level, has karst topography, and is poorly drained. The vegetation in this portion is Cedar Glades (*Quercus, Juniperus,* and *Sporobolus*). This rare vegetative type is found only in the Central Basin of Tennessee, in northeast Alabama, and in southern Missouri. The outer portion of the basin has the same vegetation as the Highland Rim.

The Western Valley of the Tennessee River separates the Highland Rim from the Coastal Plain. This region consists of the river, the flood plain (which has numerous small tributaries), and the rest of the valley proper. Where the Tennessee River returns to the state there is an incursion of oak-hickory-pine forest (*Quercus-Carya-Pinus*). This is the

Figure 10. Generalized physiolographic map of Tennessee. Source: *The Geologic History of Tennessee* by Robert A. Miller. Bulletin 74, Tennessee Department of Conservation Division of Geology, 1974.



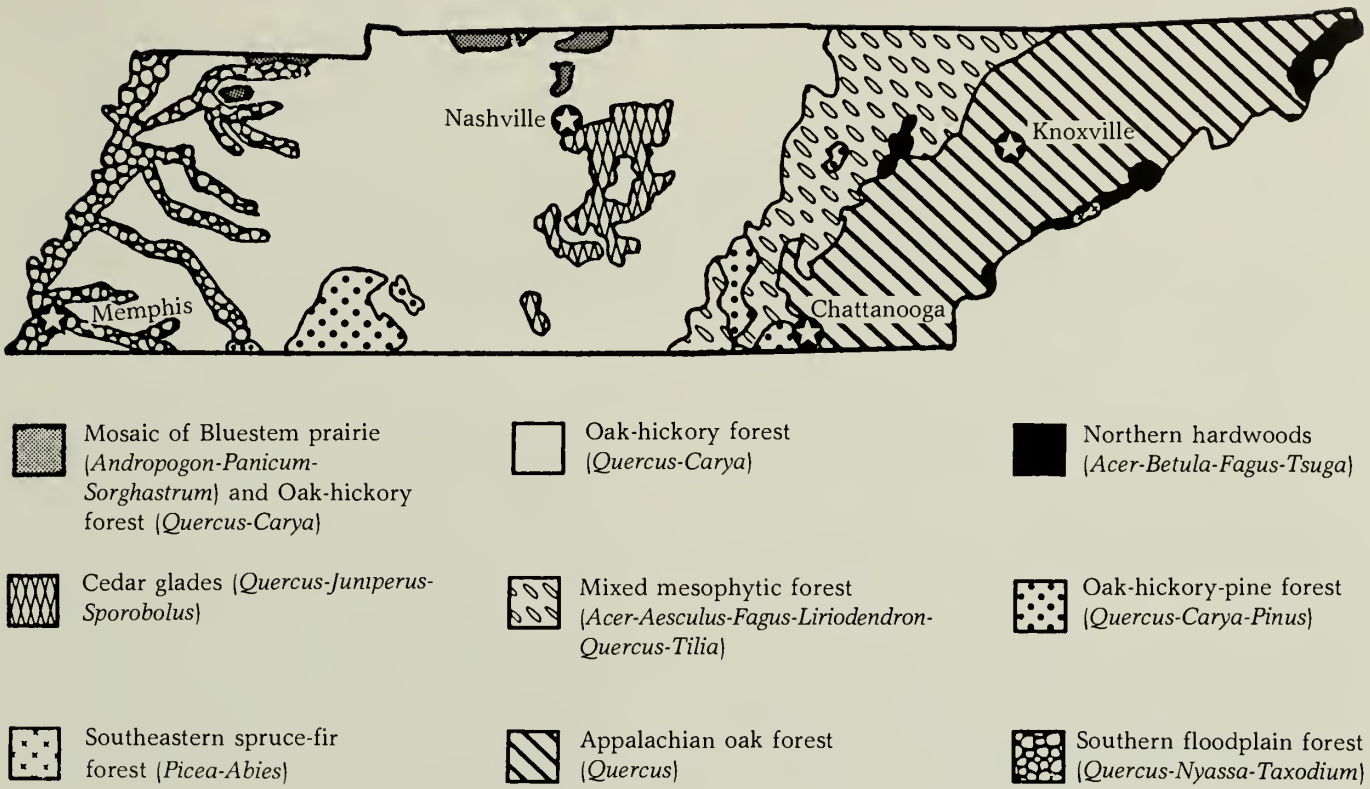


Figure 11. The major vegetative cover types of Tennessee. Source: *The National Atlas of the United States of America,* U.S. Department of the Interior Geological Survey, 1970.

predominant type of forest found in the Piedmont and Coastal Plain of the states east and south of Tennessee.

The Coastal Plain of western Tennessee is divided into two areas, the West Tennessee Uplands and, to the west of this region, the West Tennessee Plain. The Uplands have an average elevation of 500 feet, with rolling terrain. The Plain is nearly flat, and the waterways in this area meander through broad flood plains. The predominant vegetation is similar to areas to the east—oak-hickory forest. There are numerous areas of poor drainage especially along the rivers that empty into the Mississippi. The vegetation in these areas and the Mississippi River Valley region is southern flood plain forest (*Quercus-Nyassa-Taxodium*).

The westernmost region of the state is the Mississippi River Valley. In this quite narrow area (14 miles at the widest), the Mississippi River has formed many features including oxbow lakes, back swamps, cutoffs, and the distinctive Reelfoot Lake.

All eight regions of the state usually have warm, humid summers and mild winters. The areas of higher elevation are cooler by about 3°F per 1000 feet of elevation. The mean minimum January temperature ranges from 34°F in the southwest to 22°F in the highest mountains. The mean maximum July temperature is 90°F or above for most of the state, except for the Cumberland Plateau and Unaka Mountains. The top of the mountains have winter temperatures comparable to mid Ohio and summer temperatures similar to the southern edge of the Hudson Bay.

Most of the state's growing seasons range between 180 and 220 days per year. The longer growing periods are in the counties along the Mississippi River, the Central Basin, and the southern end of the Valley and Ridge province. Growing seasons are shorter in the Unaka Mountains and on the northern end of the Cumberland Plateau.

The highest amount of precipitation occurs in the winter and early spring, with a significant amount in midsummer from thunderstorms. The state has abundant rainfall, derived mostly from moist air moving up from the Gulf region. Rainfall amounts tend to decrease from the south (52-56 inches per year) to the north (48-50 inches per year) in the valleys, but rainfall is more abundant in the higher elevations—up to 60 inches in parts of the plateau and 76 inches at the top of the highest Unaka Mountains. The lowest annual rainfall is 40 inches per year in the upper Valley and Ridge area. This area is in a partial rain shadow that extends from the Great Smoky Mountains to the southeast and the Cumberland Plateau to the northeast.

The diversity of the topography and the moderate weather of the state allow for a variety of habitats that are capable of supporting the 100 or more species of Tabanidae found or suspected to be living in the state.

PART 2

Keys to Identifying the Tabanidae Occurring or Possibly Ocurring in Tennessee

KEYS TO THE GENERA OF TABANIDAE LARVAE AND PUPAE

Figure 8 (p. 8) shows several views useful when identifying Tabanidae larvae and pupae.

Larvae

1. Larva club shaped; posterior spiracle sessile on dorso-posterior surface of anal segment ----*Goniops*
   Larva not club shaped; posterior spiracle at apex of a respiratory siphon ----2
2. Entire larva covered by pubescence; length never more than 35 mm ----3
   Pubescence usually confined to anterior and posterior margins of segments or to pseudopodial regions with occasional anterior or posterior projections; readily visible integumentary striations present at least laterally, or if entirely pubescent, full-grown larva exceeds 45 mm in length ----4
3. Pubescence distinctly mottled—the dark areas green to green-black in life, brown in preserved specimens ----*Chlorotabanus*
   Pubescence uniformly yellowish, lighter ventrally ----*Diachlorus*
4. Three pairs of pseudopodia (located dorsally, ventrally, and laterally) on each of the first 7 abdominal segments ----*Chrysops*
   Four pairs of pseudopodia (as above plus an additional ventro-lateral pair) on each of the first 7 abdominal segments ----5
5. Respiratory siphon very short, ca. half as long as its basal diameter; striations present on all aspects of every segment and rather uniformly spaced; dorsal tracheae sinuous with more or less uniform taper from posterior to anterior ----6
   Respiratory siphon length ranges from slightly shorter to two or more times longer than its basal diameter; striations normally absent from dorsal and ventral surfaces of at least the pro-thorax, and more widely spaced dorsally and ventrally than laterally on other segments; dorsal tracheae usually only slightly tapered from posterior to region of first abdominal segment, where normally a distinct constriction exists ----7
6. Pubescence of anal ridge united with posterior annulus of anal segment by extensive midlateral pubescence; larva in wet, silty, or sandy soil near water ----*Silvius*
   Little or no midlateral pubescence on anal segment, the pubescence of the anal ridge and posterior annulus widely separated; larva in rotten logs or tree holes ----*Leucotabanus*
7. Respiratory siphon comprises the distal ends of two opposed sclerotized plates between which the tracheal trunks terminate in a stigmatal spine; spine in lateral view is broad basally and apically pointed, and the dorsal and ventral edges convex ----*Merycomyia*
   Stigmatal spine present or absent; if present, narrow basally with dorsal and ventral edges concave or straight in lateral views; respiratory siphon membranous and lacking sclerotized plates except for spiracular lips ----8
8. Integumentary striations absent; midlateral pubescence of anal segment an elongate oval patch usually united with posterior annulus but widely separated from pubescence of anal ridge; respiratory siphon about as wide as long; small larvae, less than 23 mm long ----*Haematopota*
   Integumentary striations present at least on lateral aspects of thoracic segments; differs with at least one other character of the above ----9
9. Median lateral surface of anal segment lacking a dorsally directed pubescent extension from anal ridge pubescence; larva usually light brown in color; striations typically present on dorsal and ventral surfaces of all abdominal segments; stigmatal spine absent ----*Hybomitra*
   Median lateral surface with a vertically directed extension of pubescence from anal ridge pubescence that at least attains middle of segment (except *T. marginalis* and *T. nigripes*, both of which lack striations dorsally and ventrally on all segments); larva typically whitish, only rarely brownish; striations usually absent either dorsally or ventrally from some abdominal segments (or entire larva pubescent); exsertile spine present or absent ----*Atylotus*
   Tabanus
   Whitneyomyia

Pupae

1. Terminal aster with a single pair of large acutely pointed tubercles; abdominal fringes with relatively stout spines of widely variable length, the largest (three pairs on tergites, one on each pleura, and a pair on sternites) uniformly positioned in fringes of each segment; spiracular prominences on thorax and abdominal segments globular ---------- *Goniops*

   Aster with two or three pairs of conspicuous tubercles; abdominal fringes and spiracular prominences otherwise ---------- 2

2. Abdominal tergum I with a row of small tubercles or spines between setiferous sublateral tubercles ---------- *Chlorotabanus*

   Abdominal tergum I lacking tubercles and spines between sublateral setae; sublateral setae may not arise from tubercles ---------- 3

3. Dorsal abdominal fringes uniseriate ---------- 4

   Dorsal abdominal fringes biseriate ---------- 6

4. Abdominal fringe spines with broad bases and of varied and irregular sizes (resembling a saw blade with irregularly sized teeth); abdominal cuticle exhibiting a netlike appearance; dorsal tubercles of aster very short and arising from base of lateral tubercles ---------- *Diachlorus*

   Abdominal fringe spines slender, with uniform length on each segment, bases not broad; abdominal cuticle not reticulate; dorsal tubercles of aster well developed ---------- 5

5. Only a ventral or ventrolateral pair of preanal combs present; callus tubercles each with two (except *brunneus*) setae ---------- *Chrysops*

   Dorsal as well as ventral or ventrolateral preanal combs present; callus tubercles unisetose ---------- *Haematopota*

6. Callus tubercles elevated 0.4 mm; globular or drop-shaped; front with prominent ridge crossing upper basal angles of antennal sheaths through bases of callus tubercles; thoracic spiracles ca. 2 mm long; length of dorsal, lateral, and ventral tubercles of aster 0.6, 0.8, and 0.4 mm, respectively ---------- *Merycomyia*

   Not as above ---------- 7

7. Basal alar tubercles with 2 setae each ---------- *Silvius*

   Basal alar tubercles with a single seta each ---------- 8

8. Tubercles of aster, at least the lateral and ventral pairs, elongate and slender, tapering gradually to apices; all preanal combs present and distinct; setae of abdominal segment I arising from tubercles; posterior series of fringe spines continuous across abdominal tergite 7; thoracic respiratory prominences not exceeding the anterior margin of thorax by more than 0.1 mm ---------- *Leucotabanus*

   Differs from more than two of the preceding ---------- 9

9. Abdominal fringes biseriate, those of anterior series of approximately equal length dorsally on all segments and/or stouter than adjacent posterior spines ---------- *Hybomitra*

   Spines of anterior series increasing in length posteriorly and of same or smaller diameter than adjacent posterior spines ---------- *Atylotus*
   Tabanus
   Whitneyomyia

KEY TO THE GENERA OF ADULT TABANIDAE

1. Hind tibia with a pair of apical spurs ---------- 2

   Hind tibia lacking apical spurs (Subfamily Tabaninae) ---------- 7

2. Third segment of antenna with at least eight annuli (Subfamily Pangoniinae) ---------- 3

   Third segment of antenna with a basal plate-like area and four or fewer terminal annuli (Subfamily Chrysopsinae) ---------- 4

3. Eye of the female with upper angles strongly acute; frons broader than width of eyes and non-pollinose over middle third; wing darkly patterned especially over anterior half ---------- *Goniops*

   Eye of female normal; frons narrower than width of eye and uniformly pollinose; wing hyaline with possible exception of costal cell ---------- *Stonemyia*

4. Third segment of antenna with two or three annuli; large species (17-23 mm) with abdomen dorsally having a large white patch indented above on fourth tergite and two white spots on both the fifth and sixth tergites; hind tibial spurs usually very small ---------- *Merycomyia*

   Third segment of antenna with four annuli; smaller species with abdominal marking blackish, brownish, yellowish, or absent; hind tibial spurs large ---------- 5

5. Pedicel about one-half length of scape; wing mostly hyaline except for numerous dark spots in apical half at crossveins and near apices of longitudinal veins ---------- *Silvius*

   Pedicel and scape of nearly equal size; wing not as above ---------- 6

6. Wing more or less evenly infuscated throughout; spur vein present at bifurcation of third longitudinal vein ---------- *Neochrysops*

   Wing with more or less distinct pattern having some hyaline areas and other areas distinctly and darkly infuscated, including in the latter in most species a distinct band of infuscation crossing or nearly crossing wing near middle; spur vein absent or present only adventitiously ---------- *Chrysops*

7. First antennal segment considerably longer than broad; frons of female widened below, broader than high, with a velvety-black spot to each side at angle made by eye and subcallus; third antennal segment with three annuli; wing gray, with small white maculations ---------- *Haematopota*

   First anntennal segment about as long as broad; frons of female not broader than high and without velvety-black spots; third antennal segment with four annuli; wing pattern, if any, otherwise ---------- 8

8. Frontal calli absent from frons of female; body compact, almost uniformly greenish-yellow ---------- *Chlorotabanus*

Frontal calli present or absent, but if absent, body not greenish yellow ---------- 9

9. Basal part of third antennal segment with a dorsal, forward-projecting, hook-like process above the annuli (see Figure 9e, p. 9); eye pilose ---------- *Hamatabanus*

Basal part of third antennal segment usually without a dorsal, forward- projecting process, but if such a process is present the eye is bare ---------- 10

10. Vertex usually with a distinct ocellar tubercle; eye generally pilose if tubercle is indistinct ---------- 11

Vertex lacking an ocellar tubercle; if vertex raised in male, it is pollinose ---------- 12

11. Eye bare; frons narrow; long and median and basal calli united, both narrow; scutellum pallid; male with thorax and abdomen covered by dense white hairs ---------- *Leucotabanus*

Eye usually distinctly pilose; frons of variable width; frontal callosity with its basal portion usually distinctly set off from the median portion and nearly as wide as frons basally; male not as above ---------- *Hybomitra*

12. Subcallus very swollen, protruding, and shiny black; gena denuded and black; wing and body black ---------- *Whitneyomyia*

If subcallus is slightly swollen; gena pollinose -------- 13

13. Third antennal segment without a dorsal angle; frons of female narrow; median callus a narrow line; wings dark apically; eye bare; fore tibia swollen; subepaulets bare ---------- *Diachlorus*

Not with the above combination of characters -------- 14

14. Frontal calli absent or vestigial; eye pilose; eye of male yellow-brown in dried specimens ----- *Atylotus*

Frontal calli well developed, with the basal portion nearly as wide as frons; at least lower facets of eye of male blackish in dried specimens -- *Tabanus*

Subfamily Pangoniinae

Four species representing two genera and two tribes make up the pangoniine fauna of Tennessee. All are moderate-sized insects averaging between 11 and 13 mm in length. None of the species of this subfamily occurring in Tennessee is known to feed on blood.

Tribe Pangoniini

Genus STONEMYIA Brennan

Since only a few specimens of this genus have been collected in Tennessee, biological data are lacking. In other areas these flies have generally been found on flowers or resting on the ground in open woodland areas (Pechuman 1972). The immature stages are unknown.

In addition to the species discussed here, Philip (1947) reported *S. fera* (Williston) (as *S. tranquilla fera*) from Tennessee. However, after discussions and correspondence with Dr. L. L. Pechuman concerning distributions of *fera* and *tranquilla,* we have chosen to follow Dr. Pechuman's interpretation of *fera* as being entirely western in distribution. For this reason, we have removed *S. fera* from the list of Tennessee species.

KEY TO STONEMYIA *SPECIES*

1. Yellowish species including antenna and legs ---------- *isabellina*

Antenna at least partly black; legs reddish to black ---- 2

2. Legs reddish brown; posterior margins of abdominal segments with grayish hairs ---------- *rasa*

Legs black; posterior margins of abdominal segments with yellow hairs ---------- *tranquilla*

***Stonemyia isabellina* (Wiedemann).** Moderate (12 mm); yellow; wing membrane very faintly tinted; costal cell yellow.

Comments: Two specimens are known from Tennessee, one from Cumberland County, collected on 27 June (sticky trap), and one from Morgan County, collected 9 June.

***Stonemyia rasa* (Loew).** Moderate length (12.5 mm); dark brown; abdominal tergites with grayish hind margins; legs reddish brown; wing membrane faintly tinted, costal cell yellow.

Comments: Philip (1947) was the first to report this species from Tennessee, but as previously noted this paper did not provide specific locality data. We have seen only a single specimen taken 30 July in the upper elevations of the Great Smoky Mountains National Park.

***Stonemyia tranquilla* (Osten Sacken).** Moderate (12.5 mm); blackish brown; abdominal tergites with reddish hind margins and rather yellowish or chestnut laterally; legs mostly black; wing membrane faintly tinted, costal cell yellow.

Comments: We have seen a single specimen from Tennessee taken 1 August 1941 in the upper elevations of the Great Smoky Mountains National Park. Other specimens are known from Clingman's Dome, 20 July, and from Knoxville, dated August.

Tribe Scionini

Genus GONIOPS Aldrich

***Goniops chrysocomus* (Osten Sacken).** Stout species (8-15 mm); body predominantly yellowish to rather dark brown, in darker forms hind margins of abdominal tergites decidely yellowish; wing with a dark pattern, more pronounced on anterior half; males typically brownish with yellowish hind margins on abdominal tergites.

Comments: This is the only species in the genus. The stout body and the wings with infuscation on anterior half, along with the key characters should prevent confusion of this species with any other. In wild-caught adults the length ranges from 10 to 15 mm, but reared specimens are as short as 8 mm.

Though collected infrequently in Tennessee, this species is primarily in the eastern third of the state with collection dates ranging from 16 June to 17 July. The female apparently does not feed on blood, and this behavior may account for the few records of collection.

Larvae are reported from the lower layers of leaf mold and from damp soil. The single collection known to us of a larva in Tennessee was from moist leaf litter on the level floor of

a small wooded valley. However, on several occasions larvae of this species have been collected in Arkansas where they are very numerous, indicating a higher potential adult population in Tennessee than do the collection records. The larvae were found in loose, rather dry soil below the leaf litter on the side of a very steep slope. This location was the same are discussed by Schwardt (1936) who also described the immature stages.

Post-oviposition behavior in this species is especially interesting. The female lays the eggs on the undersides of leaves and remains with them until they hatch, often making a loud buzzing sound if disturbed.

Subfamily Chrysopsinae

Two tribes of this subfamily are represented in the Tennessee fauna by four genera and at least 34 species. One tribe, Bouvieromyiini, includes a single species, *Tabanus*-like in appearance, and averaging about 21 mm in length. The species of the tribe Chrysopsini are all considerably smaller and categorized for comparative purposes as small if they average 7 mm or less in length, moderate if averaging between 7 and 9 mm, and large if averaging 9 mm or more in length.

Tribe Bouvieromyiini

Genus MERYCOMYIA Hine

Only two species are recognized in this genus. One, *M. brunnea* Stone, is known only from Florida and southern Georgia. The females are not known to feed on blood.

***Merycomyia whitneyi* (Johnson).** Large (21 mm); brownish; abdomen dorsally with a large white middorsal patch indented anteriorly on fourth tergite and two white spots on fifth and often sixth tergites, the whole white area resembles the letter "H"; wing with variable amounts of brown infuscation, sometimes entire wing infuscated except for subhyaline streaks in most posterior and submarginal cells; at a minimum infuscated anteriorly and basally and alongside longitudinal veins; costal cell yellowish brown.

Comments: We have seen only one Tennessee specimen of this rarely collected species. It was taken in Chester County on 4 June 1971. Notes on the biology of this species have been provided by Goodwin (1971).

Larvae of this species have been taken from mud at depths up to four feet in ponds and lakes, from the mud of stream banks, at the margins of sandy-bottomed borrow pits, and from moss at the edge of a pool (Teskey 1969; Tidwell 1973; Goodwin 1973c). Most collections have been of 1-3 specimens. However, between 600 and 1000 nearly fully grown larvae have been seen in a single bait shop in Florida where they were being sold as fish bait. The large number of larvae indicate an adult with unusual behavior in comparison to the majority of tabanid species.

Tribe Chrysopsini

Genus CHRYSOPS Meigen

The species of the genus *Chrysops* are typically referred to as "deer flies." Other common names often used in Tennessee are "May flies" and "June flies," these names referring to the months of adult activity. The genus is worldwide in distribution and is one of the largest in number of species. These flies are usually less than 11 mm and are distinctive because of 1) their bright green and gold eyes with reddish spots, 2) distinct crossband of color at the middle of wing, and 3) black and gold or solid black abdominal coloration in most species. Eye color disappears shortly after death and is of little use in routine identification, even though there is some degree of species specificity (Price and Goodwin 1979). These flies are annoying pests of man and animals, especially in wooded areas and in close proximity to water.

The earliest records of adult activity in Tennessee are in early April, but large numbers of *Chrysops* usually do not appear until early May. Numbers remain high, although species composition changes, until early September. *Chrysops* are considered by some to have more of an "ambush" type of feeding behavior than the larger horse flies and are probably less likely to travel long distances in search of hosts (Mullens and Gerhardt 1980). *Chrysops* are generally more likely to be pests at the edges of wooded areas or other ecotone habitats. Most species are poorly collected in canopy traps, but anthropophilic species are readily collected with hand nets swung about the collector's head.

Wing patterns are valuable in identification, so wing photographs follow each species description in this text for all species of *Chrysops* found in Tennessee.

KEYS TO CHRYSOPS *SPECIES*

Females

Figures 9a-d, f, and g (p. 9) and the wing photograph accompanying each species description show several views useful when identifying *Chrysops*.

1. Apex of wing beyond crossband hyaline, at most an occasional, indefinite trace of infuscation along costa ---- 2
   Apex of wing beyond crossband definitely infuscated to varying extents, i.e., "apical spot" present ---- 9
2. Frontoclypeus with a midfacial gray, yellow, or orange pollinose stripe beneath antennae extending one-half to three-fourths the distance to the oral margin ---- 3
   Frontoclypeus lacking midfacial pollinose spur or stripe ---- 6
3. Side of at least the first two abdominal segments with pale areas; wing picture rather dilute ---- *cuclux*
   Abdomen entirely blackish or with an indefinite pattern due to grayish vestiture; wing picture saturate ---- 4
4. Fifth posterior cell entirely infuscated basally; pleura with yellow to orange-red pile ---- *cincticornis*
   Fifth posterior cell with basal, hyaline lunule; hairs of pleura gray or yellowish ---- 5
5. Crossband reaches hind margin of wing rather broadly, outer margin quite straight or slightly bowed; hyaline spot at base of fifth posterior cell large, distinct, and clear-cut ---- *carbonarius*
   Crossband usually not broadly reaching hind margin of wing, outer margin irregular; hyaline spot at base of fifth posterior cell usually not clear-cut, sometimes almost obsolete ---- *ater*

6. Wing picture dilute, crossband fading well before hind margin ----------7
Wing picture with crossband saturate and complete to hind margin ----------8
7. First basal cell dilutely infuscated; abdomen entirely dark ----------*nigribimbo*
Both basal cells entirely hyaline; abdomen with contrasting yellow and black pattern basally ----------*fulvistigmus*
8. Bare integument of ocellar area extends uninterrupted over top and back of head to occiput; sublateral thoracic stripes distinct ----------*calvus*
Bare integument of vertex interrupted by a transverse pollinose band between ocellar area and occiput; sublateral thoracic stripes indistinct ----------*niger*
9. Bifurcation of third longitudinal vein (the fork) with a prominent, isolated spot or this may be an extension from the crossband (occasionally faint in dusky specimens) ----------*brimleyi*
The fork with no prominent spot though the area may be included in apical tinting of the wing or in occasional specimens with bicolored bodies there may be indefinite shadow ----------10
10. Crossband and apical spot fragmented by diluted vein margins; abdomen striate ----------*shermani*
Vein margins in crossband and apical spot not diluted; abdomen variable ----------11
11. Apical spot dilutely extended around wing, reducing hyaline triangle to a subhyaline area not reaching hind margin of wing; large brown species with swollen first antennal segment; little or no trace of abdominal markings--*brunneus*
Not with above combination of characters ----------12
12. First basal cell almost completely infuscated (e.g., *moechus,* Figure 32); if there is a hyaline spot in the apex, it does not plainly cross the cell (e.g., *calvus,* Figure 17, or *indus,* Figure 29, in contrast to *ater,* Figure 12, or *carbonarius,* Figure 18)-------13
First basal cell with at least a subapical hyaline spot crossing the cell, sometimes almost entirely hyaline (in *C. montanus* a spur occasionally reaches apex, it does not plainly cross the cell) ----------23
13. Abdominal dorsum black, with large yellow median triangles on tergites, third and succeeding segments with yellowish hind margins----------*indus*
Abdominal dorsum otherwise marked, either vittate, striate, unicolorous or with median and sometimes sublateral yellowish stripes ----------14
14. Hyaline triangle small but clear and distinct, restricted to second and third posterior cells ----------*moechus*
Hyaline triangle extends toward costal margin at least beyond the fork ----------15
15. Hyaline triangle extends to costal margin thus isolating apical spot; black species, abdomen without pattern; frontoclypeus black with median pollinose stripe----------*separatus*
Apical spot distinctly united with crossband anteriorly; species color variable; if abdomen unicolorous, frontoclypeus yellowish-brown ventrally ----------16
16. Predominantly black or fuscous species with paler abdominal markings, if any, not conspicuous; hyaline triangle usually narrow and crescent shaped, reaching second longitudinal vein but sometimes upper portion of hyaline triangle tinted so that it is indistinct ----------17
Abdomen conspicuously yellow and black ----------19
17. Thorax with a conspicuous yellow stripe on each side above the wing base ----------*obsoletus*
Thoracic yellow bands confined to the pleura---------18
18. Hind leg predominantly yellowish to brown; abdomen usually with one to three faint to distinct gray or yellow stripes; apical spot crossing into first posterior cell at least as a shadow---------*dacne*
Hind leg predominantly fuscous; abdomen dark, occasionally with obscure pattern on tergite 2; apical spot usually fading in second submarginal cell----------*parvulus*
19. Apex of hyaline triangle reaches or exceeds second longitudinal vein ----------20
Apex of hyaline triangle not reaching second longitudinal vein ----------22
20. Hyaline triangle terminating broadly at second longitudinal vein; frontal callus dark brown to black; lateral dark stripes of abdominal dorsum extending anteriorly only to the posterior margin of tergite 2 ----------*pikei*
Hyaline triangle pointed apically, distinctly exceeding second longitudinal vein; either frontal callus yellow or lateral dark stripes extending onto and usually crossing tergite 2 ----------21
21. Frontal callus black; fifth posterior cell predominantly infuscated----------*sequax*
Frontal callus yellow; fifth posterior cell essentially hyaline----------*beameri*
22. Abdomen with four more or less complete dark longitudinal stripes; thorax yellow with distinct black stripes ----------*vittatus*
Abdomen with a prominent median yellow stripe bordered by black of varying width, sides yellow; thorax fuscous with indistinct stripes ----------*macquarti*
23. Abdomen brownish black dorsally with a median yellowish stripe, although it may be faint ---------24
Abdomen otherwise marked, always with distinct yellowish or pale areas----------25
24. Frontoclypeus usually with a median pollinose T-shaped mark; costal cell with infuscation lighter than crossband ----------*upsilon*
Frontoclypeus without such a mark, essentially nonpollinose; costal cell same color as crossband ----------*univittatus*
25. Abdomen quadristriate or vittate, usually with a median, inverted "V" on tergite 2; apical spot drop shaped, usually half filling second submarginal cell, the apex of the hyaline triangle often reaching or even crossing second longitudinal vein; frontal callosity and scutellum typically black but the former occasionally with

yellowish shades ----------*montanus*
Not with this combination of characters----------26
26. Apical spot narrow, usually not noticeably widened beyond base, entering only into extreme apex of second submarginal cell ----------27
Apical spot broad, covering at least apical third of upper branch of third longitudinal vein and obviously widened beyond base ----------28
27. Apical spot just beyond where it leaves crossband slightly wider than marginal cell; frontal callus usually yellow, often bordered with black or brown, occasionally black ----------*pudicus*
Apical spot at base narrower or just as wide as marginal cell; frontal callosity black----------*callidus*
28. Hyaline triangle distinctly crosses second longitudinal vein, nearly separating apical spot from crossband ----------29
Hyaline triangle at most reaches second longitudinal vein ----------31
29. Apical spot occupies only about half of second submarginal cell; crossband usually does not reach hind margin of wing----------*lateralis*
Apical spot occupies almost all of second submarginal cell; crossband reaches hind margin of wing ----------30
30. Second tergite with a pair of submedian dark dashes ----------*geminatus*
Second tergite entirely yellow ----------*impunctus*
31. Hyaline triangle reaches second longitudinal vein ----------32
Hyaline triangle does not reach second longitudinal vein ----------33
32. Crossband dilute and basal portion of discal cell pale or hyaline; frontal callus and hind femora yellow; usually no dark spot under scutellum ----------*cursim*
Crossband not very dilute and basal portion of discal cell usually concolorous with rest of crossband; frontal callus yellow or fuscous and hind femora usually dark at base; dark spot under scutellum ----------*pudicus*
33. Abdominal markings black; median marking of second abdominal tergite usually reaches anterior margin; frontal callus normally black but sometimes yellow; at least basal portion of hind femora black----------*dimmocki*
Abdominal markings brown, often quite pale; median marking of second abdominal tergite rarely attains anterior margin; frontal callus and hind femora yellow, latter sometimes brownish at base----------34
34. Outer margin of crossband usually rather straight; thorax typically yellowish with brown stripes; inverted "V" on tergite 2 not especially flattened and sides of this tergite brownish yellow; hind femora yellow----------*flavidus*
Outer margin of crossband usually sinuous; differing in one or more of remaining characters ----------35
35. Thorax with yellow and brown stripes; tergite 2 with median inverted "V" flattened to about one-half the length of the tergite leaving an anterior pale greenish-yellow area----------*reicherti*
Thorax grayish green with fuscous stripes; tergite 2 not as above----------*celatus*

Males

Figures 9b-d, f, and g (p. 9) and the wing photograph accompanying each species description show several views useful when identifying *Chrysops*.

1. Apex of wing beyond crossband hyaline, at most an occasional indefinite trace of infuscation along costa----------2
Apical spot present and distinct ----------9
2. Frontoclypeus with a midfacial gray, yellow, or orange pollinosity at least forming a stripe on the upper half, usually more ----------3
Frontoclypeal pollinosity absent, or at most forming a midfacial spur less than half the distance to the oral margin from the base of the antenna ----------6
3. Side of at least the first two abdominal tergites with integumental pale areas ----------*cuclux*
Abdomen black, sometimes with patches of pale pubescence----------4
4. Fifth posterior cell with basal hyaline lunule----------5
Fifth posterior cell infuscated basally ---------*cincticornis*
5. Outer margin of crossband straight or slightly and evenly bowed; crossband usually reaching hind margin of wing in fourth and fifth posterior cells in full intensity; hyaline area at base of fifth posterior cell large and sharply defined ----*carbonarius*
Outer margin of crossband usually bowed or irregular; crossband not usually reaching wing margin in full intensity; hyaline area at base of fifth posterior cell usually not with clearly defined margin; apical area of wing sometimes dilutely infuscated----------*ater*
6. Wing picture saturate; frontoclypeus yellow with large black spot on each side ----------7
Wing picture dilute; frontoclypeus dark----------8
7. Thoracic stripes fairly distinct; rarely a spot at bifurcation of third longitudinal vein ----------*calvus*
Thoracic stripes obsolete; often a spot at bifurcation ----------*niger*
8. Abdomen and first basal cell entirely blackish ----------*nigribimbo*
Abdomen with a basal yellow pattern; first basal cell not infuscated ----------*fulvistigmus*
9. Entirely black; apical spot distinctly separated from crossband; both basal cells infuscated -----*separatus*
Not with above combination ----------10
10. Abdomen black with no yellow markings; hind femora black ----------11
Yellow markings on abdomen; hind femora variable---13
11. Apical spot not covering all of second submarginal cell ----------*brimleyi*
Apical spot includes all of second submarginal cell---12
12. Hyaline triangle clear, restricted to apices of second and third posterior cells; thorax usually with at least trace of pale stripe above wing base; facial area with considerable yellow ----------*moechus*

Hyaline triangle dilutely infuscated; no trace of a pale stripe above wing base; yellow of facial area restricted to narrow stripe in center of frontoclypeus ---- *parvulus*

13. Crossband and apical spot broken by dilute areas along veins ---- *shermani*
    Crossband and apical spot not broken by dilute areas ---- 14
14. Wing pattern dilute and indefinite; first antennal segment somewhat swollen ---- *brunneus*
    Wing pattern clear cut and hyaline triangle open at hind margin of wing; first antennal segment not especially swollen, often very slender ---- 15
15. Black species; abdomen with yellowish median longitudinal stripe, occasionally with similar abbreviated stripe on each side; hyaline triangle crosses second longitudinal vein; apical spot rarely occupies more than half of second submarginal cell, often less ---- 16
    Not with above combination of characters ---- 17
16. Frontoclypeus with a prominent median pollinose stripe ---- *upsilon*
    Frontoclypeus without such a stripe, essentially non-pollinose ---- *univittatus*
17. Apical spot very little broader at its apex than at its origin, crossing upper branch of third longitudinal vein at its apex and occupying very little of second submarginal cell ---- *callidus*
    Apical spot considerably broadened toward its apex, crossing at least half of upper branch of third longitudinal vein ---- 18
18. Abdomen bright yellow and black; large black figure of second abdominal segment broadly joined to black figure of first segment; median yellow triangles do not reach anterior border of segments; apical spot occupying one-half to two-thirds of second submarginal cell ---- 19
    Not with above combination of characters ---- 20
19. Abdomen with sublateral row of black spots, median yellow triangles moderate in size; hyaline triangle extending beyond bifurcation of third longitudinal vein, sometimes reaching second longitudinal vein ---- *montanus*
    Abdomen without sublateral row of black spots, median triangles very small, sometimes obsolete; hyaline triangle ends at bifurcation of third longitudinal vein ---- *indus*
20. Apical spot filling about half or less of second submarginal cell ---- 21
    Apical spot filling all or nearly all of second submarginal cell, sometimes extending into first posterior cell ---- 27
21. Frontoclypeus with black spot on each side; hyaline triangle crosses second longitudinal vein ---- *lateralis*
    Frontoclypeus entirely yellow; hyaline triangle does not cross second longitudinal vein ---- 22
22. First basal cell infuscated, except for subhyaline area near apex; second basal cell at least half infuscated; hind femora usually partly black ---- *dimmocki*
    First basal cell one-third infuscated; hind femora often entirely yellow; dark markings on second abdominal segment not reaching anterior margin ---- 23
23. Thorax yellow or brownish in ground color with brown stripes ---- 24
    Thorax greenish gray with fuscous stripes ---- 25
24. Outer margin of crossband nearly straight; abdomen with uniformly yellowish ground color; legs yellow ---- *flavidus*
    Outer margin of crossband sinuous; abdomen usually with greenish cast to base of second segment; legs brownish ---- *reicherti*
25. Crossband dilute, base of discal cell nearly hyaline; ground color of abdomen bright yellow; hind femora entirely yellow ---- *cursim*
    Crossband saturate or nearly so, discal cell not paler at base; ground color of abdomen dull yellow; hind femora variable ---- 26
26. Hind femora usually dark at base; black spot beneath scutellum; dark abdominal markings usually saturate ---- *pudicus*
    Hind femora usually entirely yellow; black spot beneath scutellum very pale or absent, dark abdominal markings often faded ---- *celatus*
27. Hyaline triangle crosses second longitudinal vein; yellow species with black median abdominal spots that are sometimes joined on second segment or second abdominal segment entirely yellow; apical spot does not extend beyond second submarginal cell ---- 28
    Not with above combination of characters ---- 29
28. Second tergite with a pair of submedian dark dashes ---- *geminatus*
    Second abdominal segment entirely yellow ---- *impunctus*
29. Hyaline triangle reaches or nearly reaches second longitudinal vein (if subhyaline beyond bifurcation of third longitudinal vein; predominantly black species with pale abdominal markings reduced) ---- 30
    Hyaline triangle scarcely extends beyond bifurcation of third longitudinal vein; predominantly yellowish species with dark abdominal markings ---- 34
30. Blackish species, with reduced pale abdominal markings ---- 31
    Yellow species with black abdominal markings ---- 32
31. Thorax with a yellow stripe on each side above wing base; lower border of second basal cell infuscated ---- *obsoletus*
    Thorax without yellow stripe above wing base; lower border of second basal cell not more heavily infuscated than adjoining portion of cell ---- *dacne*
32. Frontoclypeus with a large dark spot on each side and cheeks with considerable black ---- *pikei*
    Frontoclypeus and cheeks mostly yellow ---- 33
33. Second basal cell hyaline; thoracic stripes distinct, yellowish ---- *beameri*
    Second basal cell largely infuscated; thoracic stripes indistinct, greenish ---- *sequax*
34. Abdomen has median yellow stripe with longitudinal black band on each side; lateral margins of segments narrowly yellow ---- *macquarti*

Abdomen yellow with four more or less complete rows of black spots ----------*vittatus*

***Chrysops ater* Macquart.** Moderate (8 mm); black; frontal callus and frontoclypeus black; thorax black with two grayish yellow stripes; abdomen without distinct pattern; both basal cells infuscated over more than basal half; apical spot absent although there is occasionally a trace of apical infuscation; vague hyaline area at base of fifth posterior cell; outer margin of crossband usually irregular. Male with both basal cells infuscated for at least basal three-quarters; wing with apical infuscation but no distinct apical spot.

Comments: This is a northern species that may occur in the eastern mountains, but it has not been collected in Tennessee. It has been found in Virginia and West Virginia. The immature stages of this species are unknown.

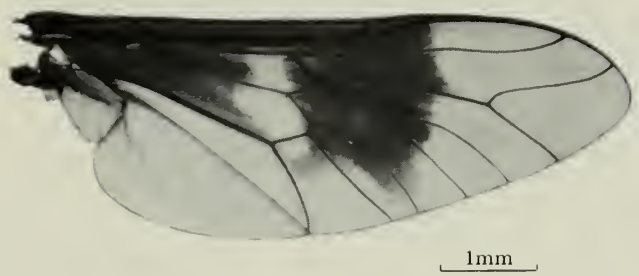


Figure 12. Wing of ater.

***Chrysops beameri* Brennan.** Moderate (8 mm); yellow and black; frontoclypeus and frontal callus yellow; thorax yellow to greenish yellow with black stripes; abdomen dorsally with four longitudinal black stripes; wing with first basal cell infuscated, second hyaline; apical spot wide; hyaline triangle exceeding second longitudinal vein. Male similar to female.

Comments: This species was reported from Carroll County by Snow et al. (1957) and has since been collected only in Madison County. Dates of collection were 27-30 June. The immature stages of this species are not known.

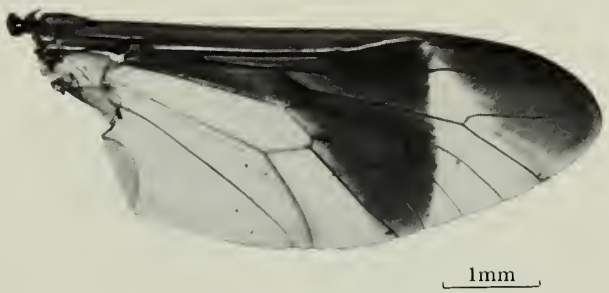


Figure 13. Wing of *beameri*.

***Chrysops brimleyi* Hine.** Small (6-7 mm); dark, black with grayish pruinosity; frontal callus brown; frontoclypeus predominantly yellow, brown at sides; abdomen sometimes with traces of grayish pattern; wing with first basal cell partly infuscated, second hyaline; apical spot narrow. Male similar to female except both basal cells partly infuscated and apical spot sometimes broader.

Comments: This species is well distributed in the eastern portion of the state, where it may be a pest of man around mid May. It is also found in Madison County. Collection dates range from 27 April to 10 June. Larvae of this species have been taken from moss or sandy soil containing much organic material along the banks of streams in pine barrens, the margins of stagnant pools, in totally organic soils of a long-abandoned cranberry bog (Teskey 1969), and from the margin of a lake in long-leaf slash pine forest (Tidwell 1973).

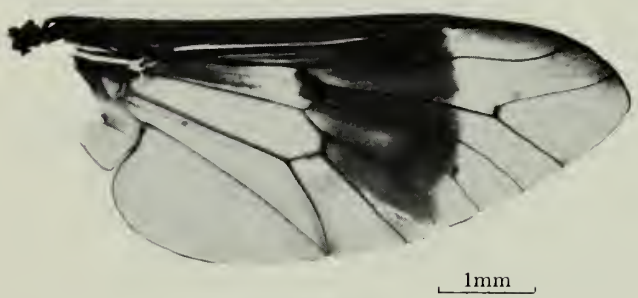


Figure 14. Wing of *brimleyi*.

Chrysops brunneus Hine. Relatively large (9 mm); brown, frontal callus and frontoclypeus yellow; thorax yellowish to greenish gray with brown stripes; abdominal pattern obsolete, some specimens with faint pale middorsal triangles; both basal cells partly infuscated; apical spot large, extending dilutely around wing margin to unite with crossband, thus isolating hyaline triangle; antennae swollen. Male similar to female.

Comments: Though it is not widespread in the state, *C. brunneus* is extremely abundant in forested areas near the shores of Reelfoot Lake and readily attacks man. It has been collected from 2 June to 21 August. Goodwin (1976a) reported taking a single larva from a clump of dead *Spartina* sp. in a salt marsh along the coast of South Carolina, but this information does not suggest the larval habitat in Tennessee since there are no salt marshes in the state.

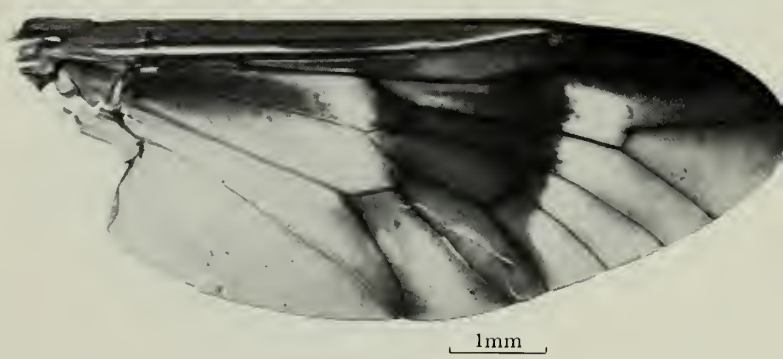


Figure 15. Wing of *brunneus*.

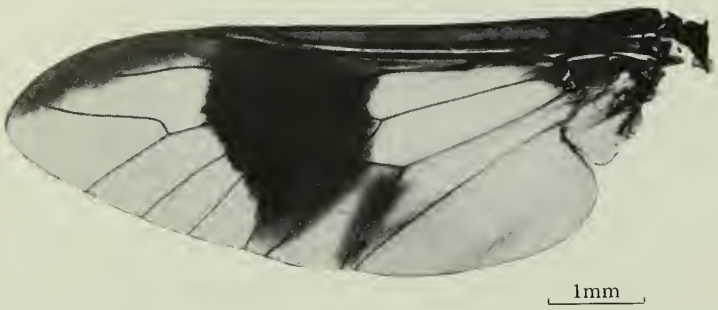


Figure 16. Wing of *callidus*.

***Chrysops callidus* Osten Sacken.** Moderate (8 mm); black and yellow; frontal callus and frontoclypeus yellow; thorax grayish to greenish yellow with black stripes; abdomen predominantly black with distinct pale middorsal triangles on tergites 2-4 or 5 and with lateral extremes of segments 1 and 2 pale; both basal cells hyaline; apical spot narrow. Male with both basal cells partly infuscated and with pale markings of abdomen reduced.

Comments: One of the most common deer flies statewide, the noisy attack of *C. callidus* is a common occurrence near ponds and swampy areas from mid May through June in eastern Tennessee. The shiny, black, single-tiered egg masses (Figure 2, p. 2) are commonly found on emergent vegetation.

Some evidence was found for a partial second brood of this species in Cumberland County in 1978, and collection dates range from 7 May to 14 September. In addition to being a pest of man in many areas, *C. callidus* also will attack horses and cattle, and one was taken feeding on a dog.

Larvae have been collected commonly from the margins of ponds and less commonly from the margins of streams (Teskey 1969; Tidwell 1973). Typically, larvae were in the upper few centimeters of mud very near the margins of the water. Tidwell (1973) has found larvae up to 10 m from the shore in the bottom mud of ponds during the colder months. The larvae of this species have been collected at many such locations across the state.

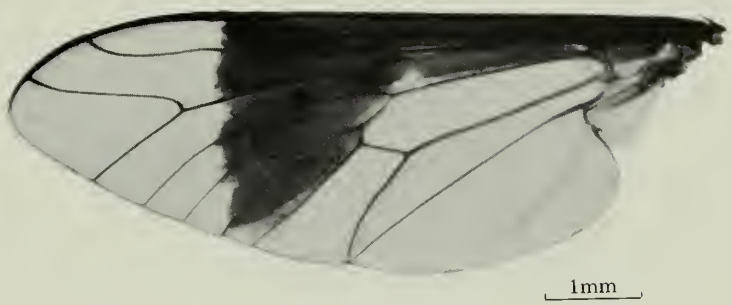


Figure 17. Wing of *calvus*.

***Chrysops calvus* Pechuman and Teskey.** Moderate (8.5 mm); blackish; frontal callus black; frontoclypeus yellow except for black of tentorial pits; thorax with distinct grayish yellow sublateral stripes and yellow stripe laterally above each wing base; abdomen without pattern; first basal cell infuscated, second hyaline; apical spot absent or present only as a narrow line along costal border; central area of vertex black, completely bare. Male with both basal cells predominantly infuscated.

Comments: This species tends to be northern in distribution, but its range extends southward along the Appalachians. One population was found at Rafter, Monroe County, where the species was collected from 18 May to 2 June. Larvae were taken from saturated clay soil on the banks of a pool of a stream in New York (Teskey 1969); the soil contained little organic matter and was devoid of vegetative growth.

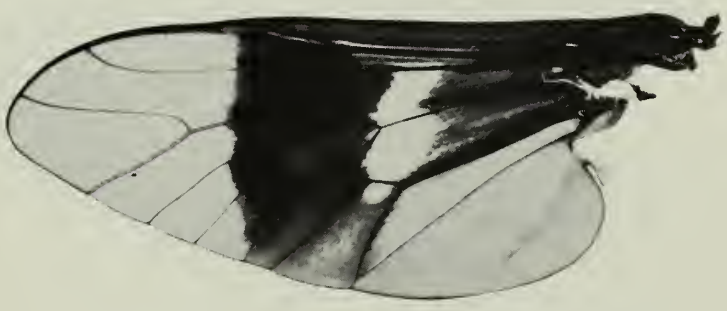


Figure 18. Wing of *carbonarius*.

***Chrysops carbonarius* Walker.** Moderate (8.5 mm); black; frontal callus and frontoclypeus brown to shining black, the latter with a yellow pollinose streak on midline; thorax with grayish to whitish pruinosity; abdomen sometimes with traces of gray middorsal triangles; both basal cells infuscated at least half of their length; apical spot absent; outer margin of crossband straight; distinct hyaline area at base of fifth posterior cell. Male with both basal cells at least three-fourths infuscated.

Comments: Scattered records exist from 14 May to 23 June in eastern and western parts of the state, but *C. carbonarius* is not a common species. Teskey (1969) collected larvae of this species from the banks of streams; most of the streams were swift and had sand and gravel banks and only small quantities of silty materials.

***Chrysops celatus* Pechuman.** Moderate (8.5 mm); yellowish brown; frontal callus and frontoclypeus yellow; thorax greenish gray with brown stripes; abdomen yellowish with brown geminate median spot on second tergite; remaining tergites brown bordered by yellow that expands into middorsal triangles; first basal cell infuscated over most of basal half, second only at base; outer margin of crossband sinuous. Male similar to female.

Comments: *Chrysops celatus* has been collected from 13 to 30 June, but is not common in Tennessee. Teskey (1969) and Tidwell (1973) reported collections of larvae of this species. Habitat varied from almost pure wet sand to totally organic soil. Larvae were taken along streams, at the margins of ponds, from around the roots of aquatic vegetation at the base of cypress trees, and from an abandoned cranberry bog. The larvae of this species have been collected from similar habitats in Tennessee.

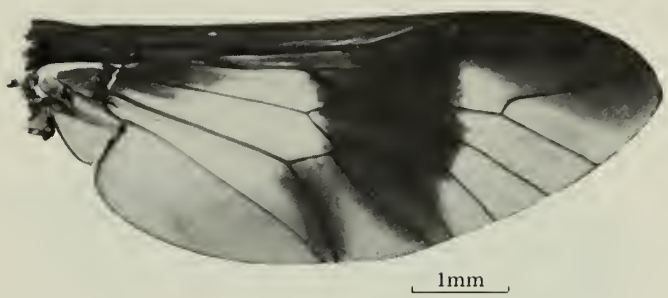


Figure 19. Wing of *celatus*.

***Chrysops cincticornis* Walker.** Relatively large (9 mm); black; frontal callus and frontoclypeus black, the latter with a broad longitudinal pollinose stripe on midline; thorax with white pubescence and faint gray stripes; pleura with dense yellow to orange-red pile; abdomen with white pubescence and indistinct gray middorsal triangles on segments 2 and 3; both basal cells infuscated over more than half their length; apical spot absent; fifth posterior cell infuscated at base. Male lacking yellow or orange pile; anal area of wing dilutely infuscated.

Comments: This robust species commonly attacks man, but seldom in large numbers. The multi-tiered, dark brown egg masses are often found on emergent vegetation near pond edges. Collection dates range from 10 May to 27 June. Larvae have been taken from moss, silt, muck, clay, mud, and almost pure sand on the margins of stagnant and fresh water ponds and lakes and along slow-flowing streams (Teskey 1969; Tidwell 1973).

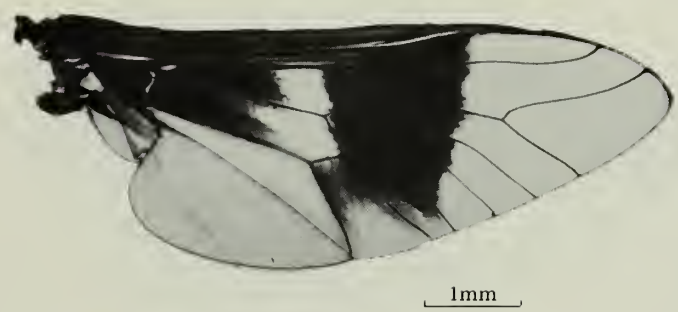


Figure 20. Wing of *cincticornis*.

***Chrysops cuclux* Whitney.** Moderate (8 mm); black; frontal callus and frontoclypeus dark brown, the latter with a broad longitudinal yellowish pollinose stripe on midline; abdomen with grayish yellow area laterally near base; both basal cells infuscated over more than half their length, the pattern faint but distinct in second; apical spot absent. Male with pale area of abdomen reduced.

Comments: Records for *C. cuclux* are restricted to the mountainous areas in eastern Tennessee. It is seldom abundant, but most records are from late May, with collection dates ranging from 1 May to 6 June. Larvae have been taken from saturated clay, silt, or muck, invariably with only sparse vegetation, typically along streams (Teskey 1969).

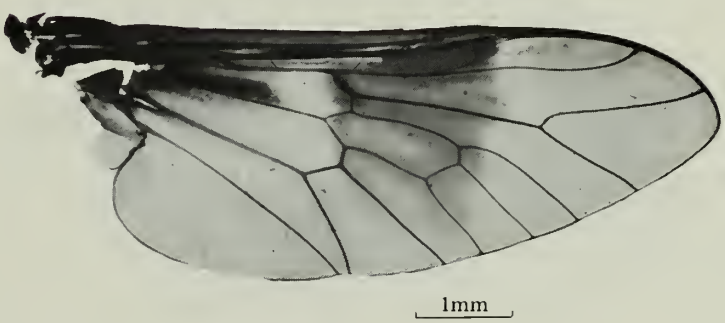


Figure 21. Wing of *cuclux*.

***Chrysops cursim* Whitney.** Moderate (7.5 mm); yellow and black, the former predominant; frontal callus and frontoclypeus yellow; thorax grayish yellow with brown stripes; black markings of abdomen form an isolated inverted V-shaped spot on second tergite, that of succeeding tergites forming more band-like areas along anterior margins; both basal cells hyaline; crossband dilute; part of discal cell subhyaline; apical spot moderately broad. Male with both basal cells partly infuscated; crossband less dilute.

Comments: This beautiful little species has been collected

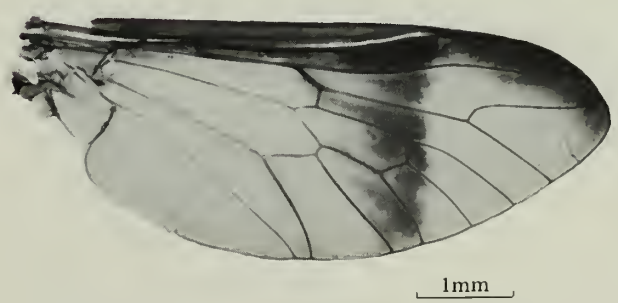


Figure 22. Wing of *cursim*.

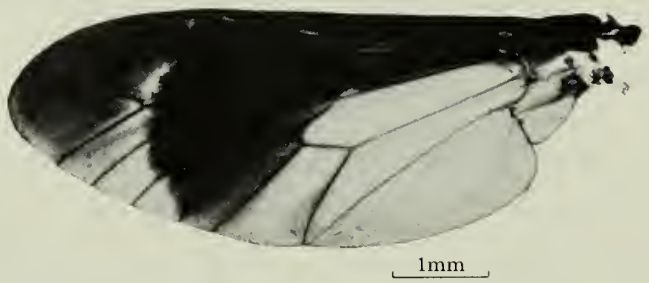


Figure 23. Wing of *dacne*.

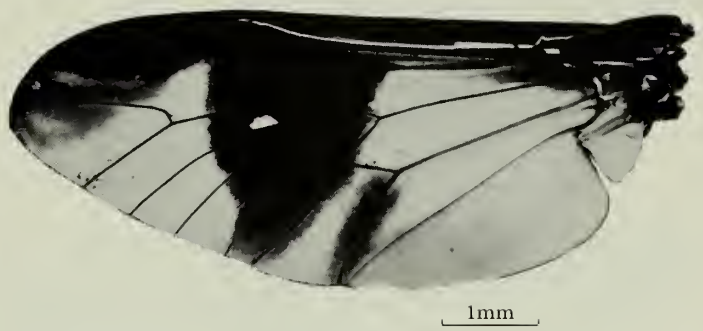


Figure 24. Wing of *dimmocki*.

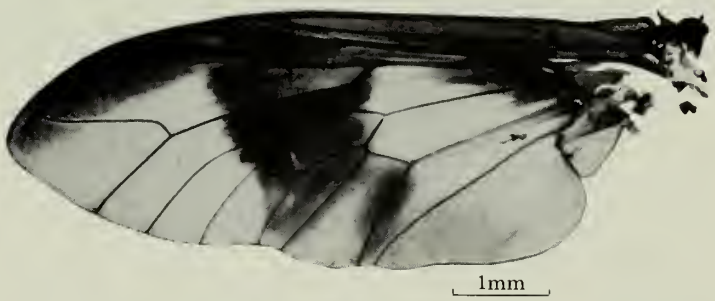


Figure 25. Wing of *flavidus*.

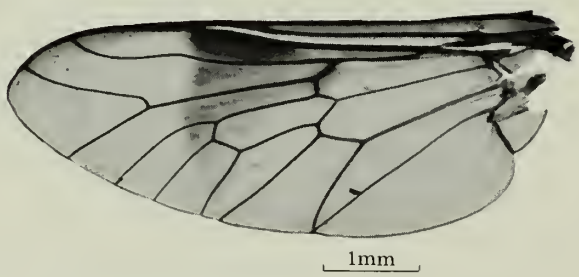


Figure 26. Wing of *fulvistigmus*.

from 29 May to 27 July. Though not a common species statewide, it is fairly common at Rafter, Monroe County, in early July and will attack both man and cattle. The immature stages of this species are not known.

***Chrysops dacne* Philip.** Moderate (7.5 mm); dark brown; frontal callus dark brown; frontoclypeus predominantly brownish yellow, darker at sides; thorax brown with grayish stripes but lacking pale stripe above wing base; abdomen with yellow typically forming narrow median stripe and rarely obsolete lateral stripes; first basal cell infuscated, second hyaline; apical spot very broad; hyaline triangle narrow. Male with hyaline areas of wing faintly tinted.

Comments: *Chrysops dacne* is found primarily in the western part of the state, where it can be very abundant in lowland hardwood forests that are periodically flooded. It will attack man and livestock and has been collected from 10 May to 17 July. The immature stages of this species are not known.

***Chrysops dimmocki* Hine.** Moderate (8 mm); black and yellow; frontal callus black to yellow; frontoclypeus yellow; thorax greenish gray pollinose with brown stripes; abdomen with black quadrate spot beneath scutellum and an inverted black V-shaped (occasionally geminate) spot on second segment; remaining segments predominantly black with yellow middorsal triangles; both basal cells hyaline; apical spot broad. Male with basal cells partly infuscated.

Comments: *Chrysops dimmocki* is known only from Chester County where it has been taken from 29 May to 20 June. Larvae have been taken from almost pure wet sand at the margin of a small stagnant pond (Teskey 1969), from moist organic muck at the bases of gum trees in a tupelo gum-cypress swamp, and from mud of a ricefield levee (Tidwell 1973). In Tennessee, larvae have been collected from saturated mud at the margins of cypress-bordered lakes in pine forests.

***Chrysops flavidus* Wiedemann.** Moderate (8.5 mm); yellow and brown; frontal callus and frontoclypeus yellow; thorax yellowish with brown stripes; abdomen yellowish basally with a low inverted brown V-shaped spot on second tergite; remaining tergites predominantly brown with yellow borders and middorsal triangles; both basal cells with infuscation in basal halves; apical spot broad; outer margin of crossband more or less straight. Male similar to female.

Comments: *Chrysops flavidus* is widespread in the state but is more common in the western portion and not often taken in eastern Tennessee. It has been collected from 25 May to 5 September and will attack both man and horses. Larvae have been collected from the bank of a fresh water pond (Teskey 1969) and at the margins of ponds and waterways in mixed bottomland/hardwood forests (Tidwell 1973). Jones and Anthony (1964) also reported collecting a single larva from the bottom of a small brook. Many larvae of this species have been collected from wet organic mud at the margins of ponds and lakes in Tennessee.

***Chrysops fulvistigmus* Hine.** Small (6.5 mm); brown to black and yellow; frontal callus and frontoclypeus black; thorax brownish with grayish pruinosity, faintly striped; abdomen with first tergite yellow laterally, black in middle

beneath scutellum; second tergite yellow with black posterior margin, with two submedian anterior black linear projections that nearly reach anterior margin; third tergite black with small median and two smaller lateral yellow spots at anterior margin; remaining tergites black; both basal cells hyaline; apical spot absent; crossband dilute. Male similar to female.

Comments: Collections of this species occurred from 2 to 13 July and were confined to three counties—Chester, Hardeman, and Madison. The immature stages of this species are not known.

***Chrysops geminatus* Wiedemann.** Small to moderate (7 mm); black and yellow; frontal callus black; frontoclypeus predominantly yellow except for black of tentorial pits; thorax yellowish with dark brown stripes; abdomen with first tergite yellow except for black spot beneath scutellum; second tergite yellow except for pair of oblique, usually isolated black submedian spots; tergites 3-5 predominantly black with yellow median line; remaining tergites black; both basal cells hyaline; apical spot broad; hyaline triangle crosses second longitudinal vein to nearly isolate apical spot. Male essentially like female except that both basal cells have some dilute infuscation.

Comments: This small, aggressive pest of man and cattle is common in the eastern Tennessee mountains in late June and early July. It is one of the few *Chrysops* that attacks man on dry ridges, in addition to more typical areas near water sources. Collection records range from 2 June to 26 July. Teskey (1969) reported taking larvae of this species from moss growing in spring-fed drainage beds and less commonly from moss on the margins of a bog lake, silty banks of a stream, and loamy soils at the margin of a flood pool. Many larvae of this species have been collected from moss and leaf litter on the surface of hillside seepage areas in mixed hardwood forest areas.

Figure 27. Wing of *geminatus*.

***Chrysops impunctus* Krober.** Small to moderate (7 mm); essentially identical to previous species except first two abdominal segments entirely yellow. Male essentially like female.

Comments: Most records for *C. impunctus* come from the eastern part of the state, and it has been collected from 20 June to 27 July. Until recently it was considered a subspecies of *C. geminatus*, but the constancy of morphological characters for both sexes indicate *C. impunctus* is a separate species. It is not as widespread as *C. geminatus*, but may be an extremely bothersome pest of man and cattle in some upland areas. Like *C. geminatus*, it can be a pest on ridges some distance from sizable water sources. The immature stages of this species are not known.

Figure 28. Wing of *impunctus*.

***Chrysops indus* Osten Sacken.** Moderate (8 mm); yellow and black; frontal callus black; frontoclypeus orange-yellow; thorax grayish yellow with brown stripes; abdomen with first tergite yellow with black spot beneath scutellum; tergites 2-5 typically with large median yellow triangles and yellow lateral and hind margins; first basal cell infuscated, second partly infuscated; apical spot broad. Male with black on abdomen more extensive and both basal cells and fifth posterior cell almost completely infuscated.

Comments: This species has a northern distribution, but

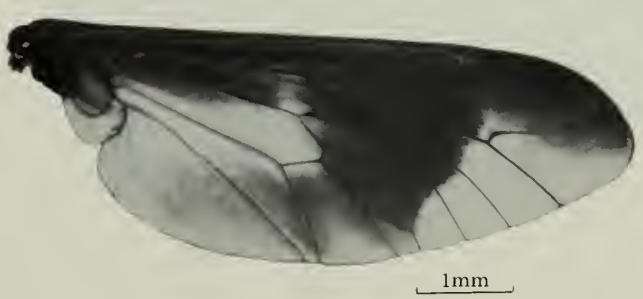


Figure 29. Wing of *indus*.

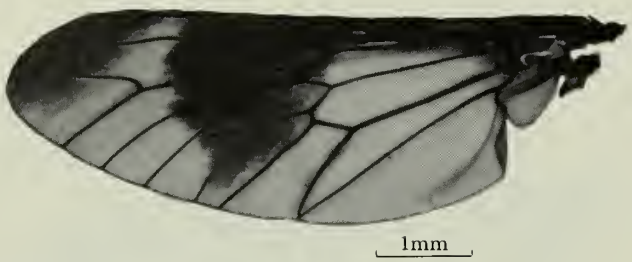


Figure 30. Wing of *lateralis*.

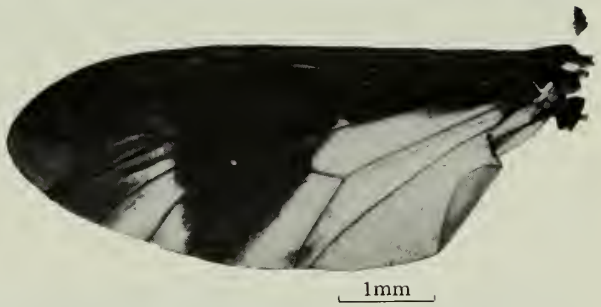


Figure 31. Wing of *macquarti*.

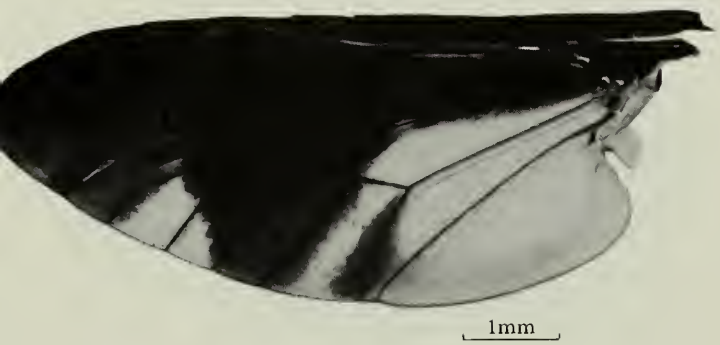


Figure 32. Wing of *moechus*.

records are known from upland areas of Virginia, North Carolina, and northern Georgia. Disjunct populations may well exist in Tennessee. The immature stages have been found in saturated mud, moss, and plant debris (Teskey 1969).

***Chrysops lateralis* Wiedemann.** Moderate (8 mm); yellow and black; frontal callus black; frontoclypeus predominantly yellow, black at sides; thorax grayish pollinose with brown stripes; abdomen with yellow median stripe, sides typically black but occasionally separated into rows of spots by sublateral areas of yellow; both basal cells hyaline; apical spot broad; hyaline triangle attains first longitudinal vein, nearly isolating apical spot. Male with some faint infuscation in both basal cells.

Comments: No Tennessee records exist for this northern species, but it may be found in the eastern mountains. Drees et al. (1980) state that it can be a pest of man in West Virginia. The immature stages are not known.

***Chrysops macquarti* Philip.** Moderate (7.5 mm); yellow and black; frontal callus dark brown to black; frontoclypeus predominantly yellow, darker at sides; thorax greenish gray with dark brown stripes; abdomen with yellow median stripe between two black stripes of variable width, sides yellow; first basal cell infuscated, second with some anterior infuscation in basal half; fifth posterior cell mostly hyaline; apical spot broad; hyaline triangle small, typically crossed by narrow infuscated band in first posterior cell that unites crossband and apical spot. Male with abdominal black stripes broader and second basal cell infuscated at least in basal half.

Comments: *Chrysops macquarti* is widespread in the state and common in many areas, particularly from mid June through early July. The silent nature of its attack makes it a fairly successful biter. Larvae are commonly collected along margins of ponds and streams. Adult records range from 31 May to 22 August. Teskey (1969) reported collecting larvae of this species from sandy, silty, and muck soils of small, usually slow-flowing streams. On one occasion a series of more than 30 larvae was collected from sandy soil in the bottom of a shallow, slow-flowing stream; the larvae were concentrated around the roots of a tree.

***Chrysops moechus* Osten Sacken.** Moderate (7.5 mm); yellow and black; frontal callus black; frontoclypeus yellow; thorax greenish with brown stripes; abdomen typically with four black longitudinal stripes separated by yellow, the median stripes extend anteriorly to segment 2 where they sometimes unite, the lateral stripes usually not extending as far forward and often irregular; first basal cell infuscated, second with infuscation anteriorly along vein; apical spot very broad; hyaline triangle small and confined to second and third posterior cells. Male black, wings almost entirely infuscated except for small hyaline triangle.

Comments: Records of *C. moechus* show it is evenly distributed in Tennessee, but it is seldom a significant pest. It has been collected from 17 May to 3 August. Teskey (1969) reported collecting two larvae, one from silt that had accumulated among gravel in a river bed and the other from wet soil liberally mixed with leaf mold at the water's edge of a small creek.

***Chrysops montanus* Osten Sacken.** Moderate (8 mm); black and yellow; frontal callus black; frontoclypeus yellow; thorax dark with grayish stripes; abdomen with median geminate spot on second tergite, sometimes with sublateral black spot on same tergite; tergites 3-5 with four rows of black spots; first basal cell partly infuscated, second with traces of infuscation at base; apical spot broad; hyaline triangle attaining or possibly exceeding second longitudinal vein. Male with both basal cells partly infuscated and yellow of body greatly reduced.

Comments: This species is not commonly collected in the state, but has been taken from 6 June to 30 June. It is the only deer fly that was more commonly collected by canopy traps than by overhead netting in Cumberland County, which may suggest it is not particularly anthropophilic or perhaps that it attacks lower body areas on animals. Teskey (1969) reported collecting larvae of this species from the muddy banks of a creek. Larvae have been found in organic mud at the margins of small ponds in mixed hardwood forests and the margins of large lakes that were devoid of tree growth along the shores.

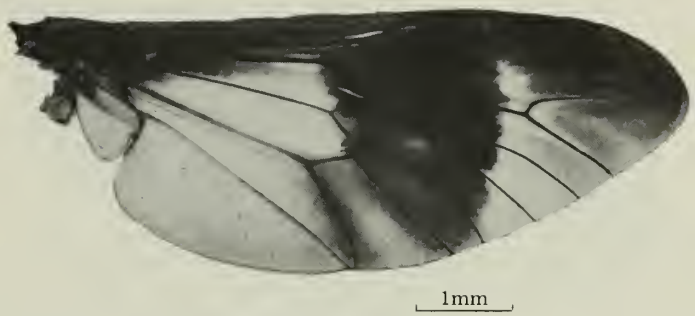


Figure 33. Wing of *montanus*.

***Chrysops niger* Macquart.** Moderate (7.5 mm); black; frontal callus black; frontoclypeus predominantly yellow except for black at sides; thorax with sublateral stripes dull or obsolete; abdomen without pattern; first basal cell infuscated, second hyaline; apical spot absent; bare area of vertex interrupted by pollinose region. Male with both basal cells predominately infuscated.

Comments: This is one of the most common and ubiquitous deer flies in Tennessee. It can be a severe pest of man from mid May to early June and will also attack horses. Extreme collection dates are 4 May and 7 July. Larvae have been taken from wet silty mud on the banks of small ponds, slow-moving streams and small rivers and also from sphagnum bogs, the margins of relatively large lakes, and swampy, spring-fed seepage beds (Teskey 1969). Tidwell (1973) reported taking larvae from the margins of a small stream and a pond. Larvae have been collected on two occasions from wet soil in floodplains adjacent to a stream and a lake; these larvae were at a depth of about 20 cm.

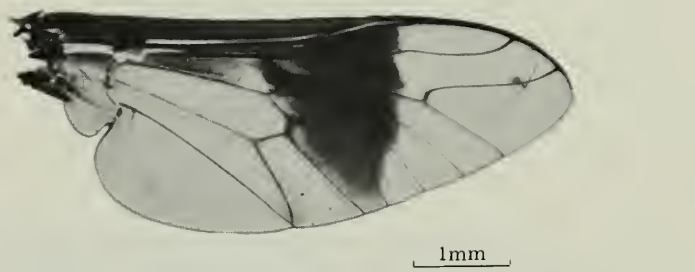


Figure 34. Wing of *niger*.

***Chrysops nigribimbo* Whitney.** Small (6 mm); dark brown to black; frontal callus dark brown; frontoclypeus predominantly yellow, darker at sides; thorax and abdomen without pattern; wing pattern very pale, first basal cell infuscated, second hyaline; apical spot absent or very faint. Male with posterobasal part of second basal cell and anal area dilutely infuscated.

Comments: One record of the collection of *C. nigribimbo* in Stewart County was among numerous records made available in 1966 by Dr. Sam Breeland, then employed by the Tennessee Valley Authority at Wilson Dam in Alabama. The date of collection was not noted, and no specimen could be located. This TVA record was the basis of the species being listed in the Tennessee fauna by Goodwin (1966). Even though no further collections have been made, we have retained it as part of the Tennessee fauna since its overall known distribution suggests that it is probably present in the state.

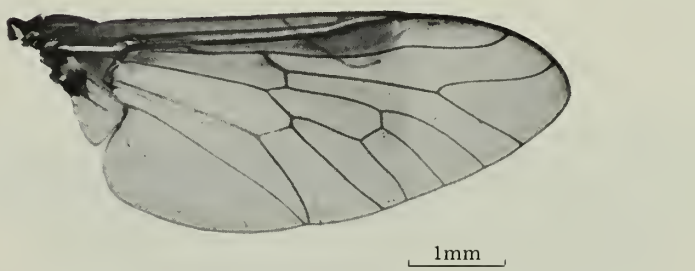


Figure 35. Wing of *nigribimbo*.

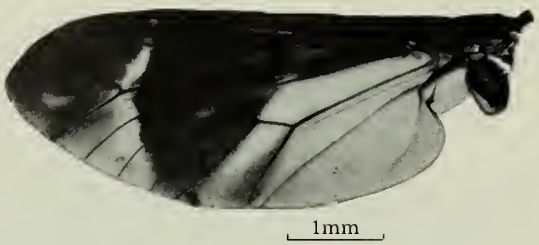


Figure 36. Wing of *obsoletus*.

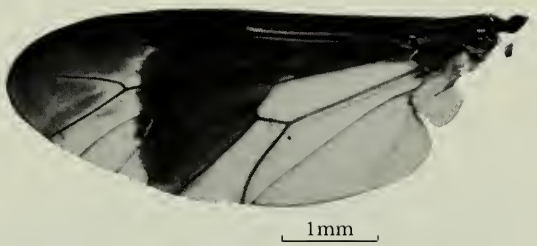


Figure 37. Wing of *parvulus*.

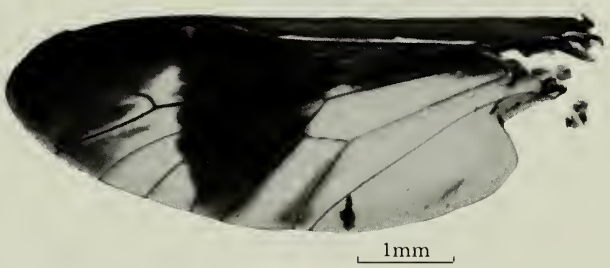


Figure 38. Wing of *pikei*.

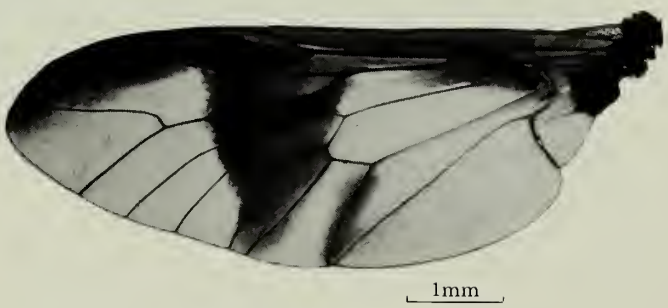


Figure 39. Wing of *pudicus*.

***Chrysops obsoletus* Wiedemann.** Moderate (8 mm); dark brown to black; frontal callus dark brown; frontoclypeus predominantly brownish yellow, darker at sides; thorax with grayish yellow stripes; abdomen with three yellowish longitudinal stripes, these often indistinct; first basal cell infuscated; apical spot broad; hyaline triangle attains second longitudinal vein rather broadly. Male with anal area and part of second basal cell dilutely infuscated.

Comments: Philip (1947) noted the collection of this species from Tennessee, but it may have been *C. dacne*, which he described in 1955. The distribution of *C. obsoletus* includes a record from central Virginia, however, and there is a slight chance of it being taken from Tennessee. Goodwin (1976b) reported taking a single larva from wet mud at the margin of a borrow pit.

***Chrysops parvulus* Daecke.** Small (6.5 mm); very dark brown or black; frontal callus and frontoclypeus dark brown, the latter with a median yellowish pollinose line; thorax without pattern, lacking pale stripe above wing base; abdomen without pattern; first basal cell infuscated; apical spot broad. Male with wing completely infuscated, but basic pattern is darker, both basal cells infuscated.

Comments: One collection record exists for this species from Henry County, 23 June. Drees et al. (1980) state it is common only in localized areas in its range, which extends from New Jersey to Florida and west to Arkansas. Teskey (1969) reported taking two larvae from moss—one along a drainage channel in an abandoned cranberry bog and one from the bank of a pool in a cedar swamp.

***Chrysops pikei* Whitney.** Rather small (7 mm); yellow, and black; frontal callus black; frontoclypeus yellow, sometimes black at sides; thorax greenish yellow with dark stripes; abdomen with four longitudinal black stripes, the lateral ones usually shorter; first basal cell infuscated, second with small basal area of infuscation; apical spot very broad, inner margin irregular; hyaline triangle broadly attains second longitudinal vein. Male with second basal cell more obviously infuscated basally.

Comments: *Chrysops pikei* is well distributed in Tennessee, though it has never been found in large numbers. Collections of this species have been made from 14 May to 14 September. Larvae of this species have been taken from a substrate of leaves mixed with silt on the bank of a creek (Teskey 1969), from debris in a narrow sandy-bottomed stream in a mixed pine-hardwood forest (Tidwell 1973), and from the muddy margin of a stagnant pool (Jones and Anthony 1964). Larvae have also been collected from moss growing on wet sandy soil at the margin of a stream in a mixed hardwood forest.

***Chrysops pudicus* Osten Sacken.** Moderate (7.5 mm); black and yellow; frontal callus typically yellow, sometimes brown at borders; frontoclypeus yellow; thorax grayish with brown stripes; abdomen with median black spot beneath scutellum, an inverted black V-shaped spot on second tergite, remaining tergites black with yellow hind margins that expand to median triangles on segments 3 and 4; first basal cell partly infuscated, second with small anterobasal area of infuscation; apical spot relatively narrow, extending into sec-

ond submarginal cell. Male with both cells partly infuscated.

Comments: This is not a commonly collected species in Tennessee, but there are a few scattered records from across the state. Extreme collection dates are 8 June and 29 August. Although Goodwin (1976a) described the pupae of this species, he noted that collection data accompanying the specimen did not include information on the habitat of the immature stages. Pechuman (1972) reported finding larvae in wet soil in a roadside ditch.

***Chrysops reicherti* Fairchild.** Moderate (8.5 mm); yellow and dark brown; frontal callus and frontoclypeus yellow; thorax yellowish with brown stripes; abdomen greenish yellow basally, predominantly brown posterior to tergite 2; first basal cell infuscated, second with some infuscation at base; apical spot broad; outer margin of crossband sinuous. Male similar to female.

Comments: Apparently restricted to the western counties, *C. reicherti* can be very abundant in some locations. Collections of adults range from 8 June to 25 August. Goodwin (1972) reported collecting many larvae of this species from wet mud and organic debris at the margin of a shallow lake in bottomland/hardwood forest. Tidwell (1973) reported taking larvae at the margins of ponds in similar areas and at the margin of a cypress swamp.

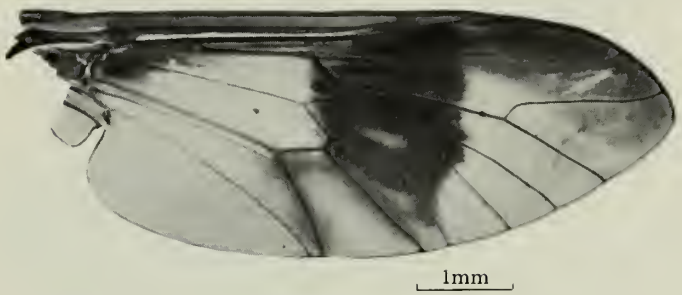


Figure 40. Wing of *reicherti*.

***Chrysops separatus* Hine.** Moderate (8 mm); black; frontal callus and frontoclypeus black, the latter with a grayish yellow pollinose streak along the midline; thorax and abdomen without pattern; first basal cell infuscated, second hyaline; apical spot relatively narrow, not united with crossband basally. Male with wing almost entirely infuscated to outer side of crossband.

Comments: This species is one of the first to be collected in the spring, with collection records from 7 April to 21 May, and this may partially account for its scarcity in collections. One specimen was observed attacking the head of a cow. The immature stages of this species are not known.

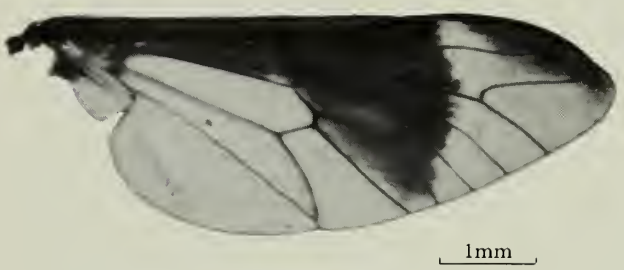


Figure 41. Wing of *separatus*.

***Chrysops sequax* Williston.** Moderate (8.5 mm); yellow and black; frontal callus black; frontoclypeus yellow except for black at sides; thorax greenish gray with brown stripes; abdomen with four complete longitudinal black stripes; first basal cell infuscated, second hyaline; apical spot broad; hyaline triangle narrow, exceeding second longitudinal vein. Male with second basal cell infuscated over basal half and yellow of body reduced.

Comments: *Chrysops sequax* has not been collected in Tennessee, but will probably be found. Both *C. sequax* and a variety, *C. s. tau,* have been collected in southern Illinois. The variety *tau* is distinguished by short pollinose projections on the frontoclypeus. Teskey and Burger (1976) reported collecting larvae of this species from soft, slimy muck soil on the margin of a man-made livestock watering pond.

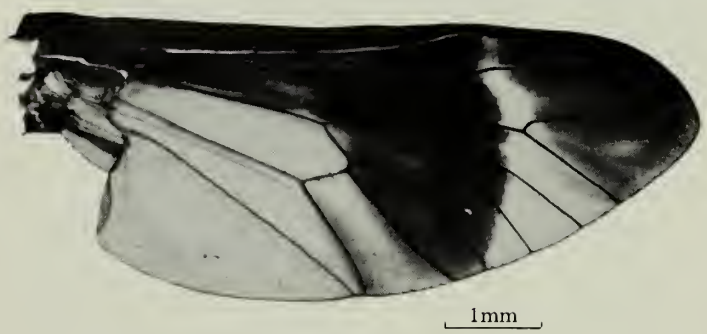


Figure 42. Wing of *sequax*.

***Chrysops shermani* Hine.** Rather large (9 mm); yellow and black; frontal callus and frontoclypeus yellow; thorax black with gray-yellowish stripes; abdomen with black spot beneath the scutellum and four longitudinal black stripes originating on segment 2, these stripes often showing varying amounts of coalescence; first basal cell palely infuscated,

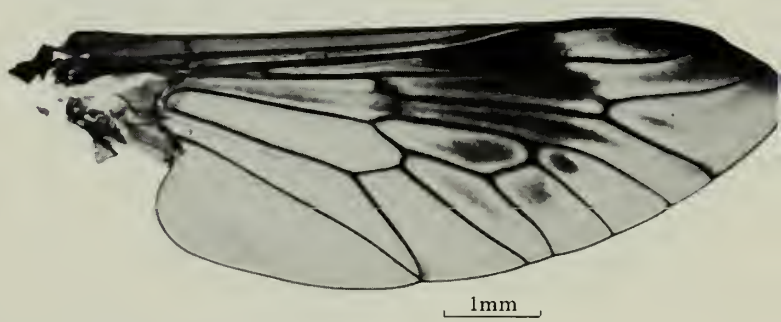


Figure 43. Wing of *shermani*.

second hyaline; apical spot only palely connected with crossband basally, entire pattern (especially crossband) interrupted by hyaline areas along veins. Male similar to female.

Comments: This species has not been collected in Tennessee, but is known from the mountains of North Carolina and Virginia, and will probably be collected eventually in eastern Tennessee. Larvae of this species were taken from a small denuded sand bar of a river (Teskey 1969).

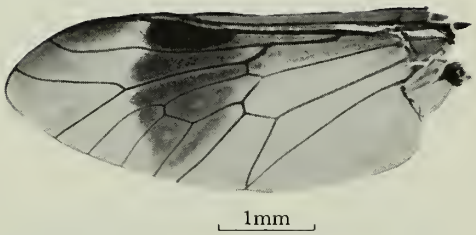


Figure 44. Wing of *univittatus*.

***Chrysops univittatus* Macquart.** Rather small (7 mm); black or dark brown; frontal callus black; frontoclypeus predominantly yellow, black at sides; thorax grayish with brown stripes; abdomen with a median yellowish stripe; both basal cells hyaline; apical spot broad but almost completely separated from crossband basally. Male with first basal cell infuscated.

Comments: *Chrysops univittatus* is very widely distributed in the state, and is a pest of man during July. It has been collected from 9 June to 6 September. Teskey (1969) reported collecting a great many larvae of this species—most from the banks of slow-moving streams, once from the muddy shores of a lake, and once from the bottom of a drainage ditch. Tidwell (1973) reported taking larvae from the margins of small streams draining long leaf-slash pine areas. This species has been collected from mud at the margins of streams and ponds at numerous locations throughout the state.

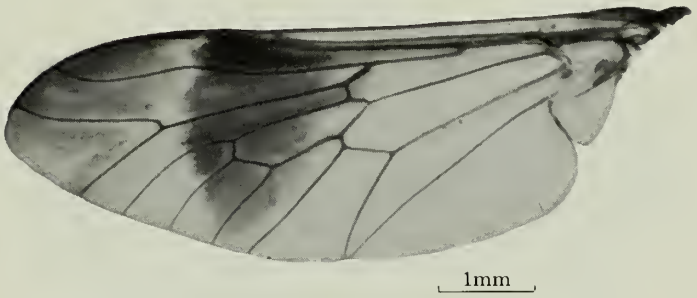


Figure 45. Wing of *upsilon*.

***Chrysops upsilon* Philip.** Moderate (8 mm); black and yellow; frontal callus black; frontoclypeus predominantly yellow except for black at sides and with a median pollinose stripe; thorax bluish green with brown stripes; abdomen with a median yellow stripe; both basal cells hyaline; apical spot very broad including all of second submarginal cell; hyaline triangle exceeds second longitudinal vein. Male with first basal cell infuscated and abdomen with traces of submedian and lateral spots on tergites 1-4.

Comments: Though it has been collected only from several Madison County locations, *C. upsilon* is a significant pest of man at Pinson Mound State Park in late June. Extreme collection dates are 9 June and 14 September. Tidwell (1973) reported taking larvae of this species from the margins of a small stream draining a long leaf-slash pine region.

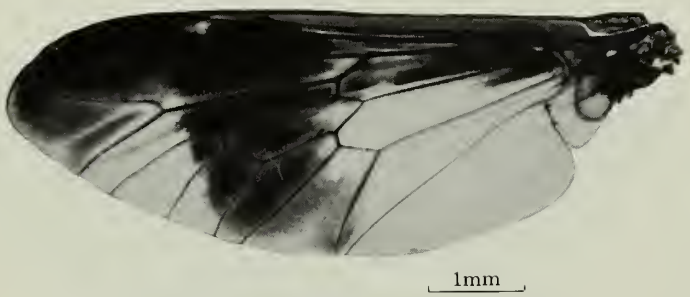


Figure 46. Wing of *vittatus*.

***Chrysops vittatus* Wiedemann.** Moderate (8 mm); yellow and black; frontal callus and frontoclypeus yellow; thorax yellow with black stripes; abdomen with four longitudinal black stripes; first basal cell infuscated, second with anterior infuscation in basal half, apical spot broad, connected posteriorly to crossband by a faint band in first posterior cell. Male with second basal cell predominantly infuscated and yellow areas of body reduced.

Comments: One of the most abundant species of deer fly in the state, *C. vittatus* readily attacks man and cattle. Collection records range from 9 June to 30 August with peak population numbers in July. Teskey (1969) reported collecting a great many larvae of this species and noted that they were present in almost all types of habitat except sphagnum bogs and other areas where concentrations of poorly decayed vegetation were present. Tidwell (1973) reported collecting larvae at the margins of a stream and a river.

Genus SILVIUS Meigen

Only one species of this predominantly western Nearctic genus is known to occur in Tennessee.

***Silvius quadrivittatus* (Say).** Moderate (8.5 mm); grayish yellow and black; frontal callus black; frontoclypeus yellowish gray pollinose; thorax yellowish gray with dark stripes; abdomen with four interrupted longitudinal black stripes; wing with isolated areas of infuscation along veins in distal half. Male similar to female.

Comments: A single adult of this species was taken on 8 June 1965 in the extreme western part of the state. Burger (1977) reported collecting larvae of this species from damp silty soil overlain by grass or vegetable debris on the steep banks of desert rivers in Arizona. Larvae have been collected from silty mud on the steep bank of a mixed hardwood forest in Tipton County, where there was no surface accumulation of grass or vegetable debris.

Genus NEOCHRYSOPS Walton

***Neochrysops globosus* Walton.** Large (9.5 mm); head and thorax *Chrysops*-like, slender; abdomen globose; thorax bright yellow with three black longitudinal stripes, none attaining anterior or posterior margins; abdomen orange-yellow with paired black sublateral spots on first five abdominal tergites, those of tergites 1 and 2 confluent and those on remaining segments isolated; wing fumose (Figure 47) darker on anterior third, apical half, and posterior edge; costal cell yellow-brown. Male essentially like female in color but abdomen not as noticeably broadened.

Comments: This is the only species in the genus. It is one of the most rarely collected species of North American tabanids and is known from less than 20 specimens including a single male. It has been reported from Maryland, Delaware, Alabama, Mississippi, and Tennessee. Nothing is known of its biology. Pechuman (1965) first reported this species from Tennessee based on a single specimen collected 9 June 1948. A second specimen, also a female, has since been collected 9-12 June 1971. This species may not feed on blood.

Subfamily Tabaninae

Three tribes represented by 9 genera and at least 59 species comprise the tabanine fauna of Tennessee. These insects range in size from rather small (7 mm) to very large (30 mm). In the brief species descriptions within this subfamily, species are termed small if average length is less than 10 mm, moderate if average length is greater than 10 mm but less than 19 mm, and large if average length is 19 mm or more.

Tribe Diachlorini

Genus DIACHLORUS Osten Sacken

***Diachlorus ferrugatus* (Fabricius).** Relatively small (7-9 mm); frons very narrow; basal callus small, brown, not touching eyes; median callus a slender line; thorax yellow without lines; abdomen with a median longitudinal stripe of yellow bordered by black (more obvious in unrubbed specimens); fore tibiae swollen; wing (Figure 48) with apex beyond fork darkened. Male similar to female.

Comments: Of the 20 species of this primarily neotropical genus listed by Fairchild (1971), only *D. ferrugatus* occurs in the United States, where its known range includes almost

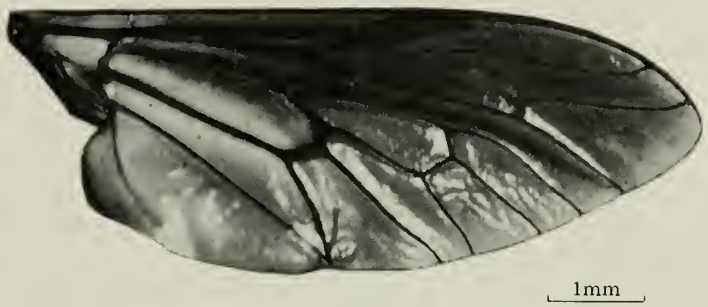


Figure 47. Wing of *Neochrysops* globosus.

all eastern and southern coastal states from New Jersey to Mexico. In many areas it is extremely numerous and a serious pest, but in Tennessee this species has been collected only twice. Possibly Tennessee marks the northern extent of the inland range of the species and suitable habitat is not sufficient to support large populations. Collection dates range from 22 June - 8 July. Larvae have been collected in sphagnum moss at the margin of a lake and in wet mud around the roots of plants growing at the margin of the same lake (Goodwin 1973a).

Genus CHLOROTABANUS Lutz

***Chlorotabanus crepuscularis* (Bequaert).** Moderate in length (13-15 mm); green to greenish yellow; frons narrow, without calli, wing hyaline, costal cell and veins yellowish; fork with an appendix. Male with eyes bare; large and small facets of eye distinctly differentiated, coloration like female.

Comments: Six species are recognized in this genus, and five are neotropical (Fairchild 1971). Only *C. crepuscularis* occurs in the United States, where its known range includes nearly all eastern and southern states from New Jersey to Mexico and extends inland into Tennessee and Arkansas. As its name implies, the adults are crepuscular. The females are blood feeders and will attack man as well as domestic and wild animals, but their crepuscular behavior prevents their being a serious human pest. Adult collections have been frequent, but rarely were large numbers taken. However, in suitable habitat, the larval stages have been collected in Tennessee and Arkansas in greater numbers than any other species of Tabaninae. Collection dates for adults range from 1 June - 25 July. Larvae have been reported from shallow water areas usually in algal mats or submerged debris (Goodwin 1973a). They have been found in large numbers among the roots of vegetation growing on floating or partly submerged logs.

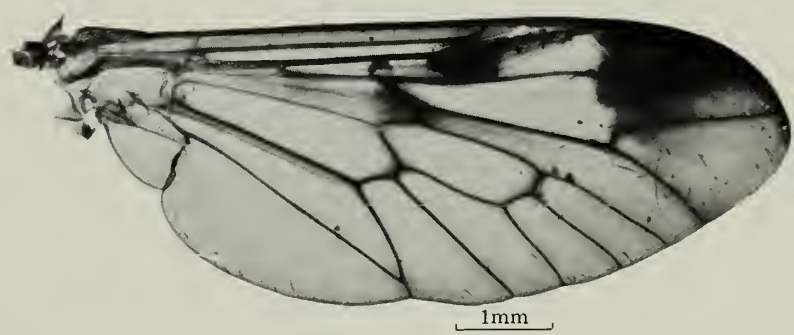


Figure 48. Wing of *Diachlorus ferrugatus*.

Genus LEUCOTABANUS Lutz

Leucotabanus annulatus **(Say).** Moderate in length (10-12 mm); orange or reddish brown and gray; frons relatively narrow, parallel sided; basal callus brown, oval, about half or less the width of frons; median callus a slender line; thorax without pattern, orange or reddish brown with yellowish orange and white hair; abdomen reddish brown with pale hind margins; wing hyaline, venation normal. Male appears whitish due to dense vestiture of white hairs; large and small facets of eye sharply differentiated.

Comments: Of the 14 species recognized by Fairchild (1971), only two are found in the United States. One of these, *L. ambiguus* Stone, is restricted to the southwest. On the other hand, *L. annulatus* is known from nearly all states from Delaware to Kansas and southward. The females are blood-feeders and have on occasion attacked man. Although widespread, large numbers have not been captured by traps, and diurnal collections have been limited. Up to 12 individuals have been observed feeding on the ventral midline of a cow at dusk and numerous adults of both sexes have been observed resting near incandescent and fluorescent outdoor lights. They appear to be markedly crepuscular and to some extent nocturnal. Goodwin (1973a) noted that larvae inhabit decomposing wood (e.g., fallen trees) and cavities in bases of living trees. The larval stages have often been found in moderately large numbers in confined areas, suggesting that cannibalism is not pronounced among the immatures. Adult collection dates range from 1 June to 29 August.

Tribe Haematopotini

Genus HAEMATOPOTA Meigen

Haematopota rara **Johnson.** Relatively small (7-9 mm); dark brown with gray markings; frons broad; basal callus black, about four times as wide as high; face above callus with a pair of large velvety black spots; thorax dark brown with three relatively slender gray stripes; abdomen with paired gray spots on most tergites; fore tibiae not swollen; wing (Figure 49) predominantly infuscated with numerous hyaline areas, the most predominant of which is a subapical band that isolates the infuscated tip of wing.

Comments: Several hundred species of *Haematopota* are currently recognized. They are primarily Old World in distribution, with the Afrotropical fauna being the most diverse. Only five species are currently recognized from North America, and *H. rara* is the only one collected to date in Tennessee. In general, females of *Haematopota* are known to be blood feeders, but little is known of the behavior of *H. rara*. It has been taken in Tennessee only once on 4 June in Union County. The immature stages are not known.

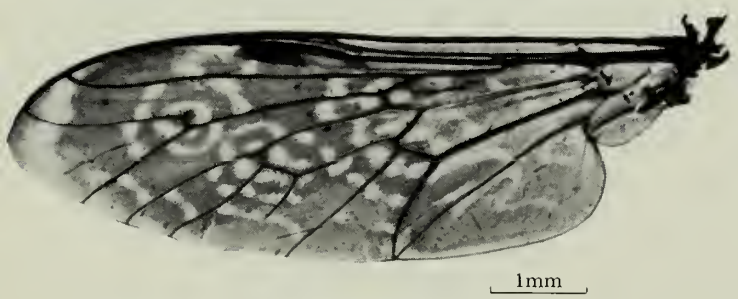


Figure 49. Wing of *Haematopota rara*.

Tribe Tabanini

Genus WHITNEYOMYIA Bequaert

Whitneyomyia beatifica **(Whitney).** Moderate in length (13-15 mm); shiny black; frontal callus large, quadrate, shiny black, united with broad concolorous median callus; remainder of frons predominantly dull black except for paired grayish spots above basal callus and grayish area at upper end of median callus; subcallus swollen, protuberant, nonpollinose, shiny black; wing more or less entirely black. Male with frontal triangle swollen, shiny black; eye bare, large and small facets distinctly differentiated.

Comments: Only a single species, represented by two varieties, is recognized in this genus, which is very southern in distribution. In the typical variety, the dorsal abdomen has the lateral thirds covered with whitish hairs. In *W. beatifica atricorpus* the abdomen is entirely black. The only known collection of this species in Tennessee was in a canopy trap near a farm pond in Knox County on 7 June. Goodwin (1976c) reported collecting a larva of this species from wet mud at the margin of a cattle pond.

Genus HAMATABANUS Philip

Hamatabanus carolinensis **(Macquart).** Moderate in length (13-16 mm); brownish with pale markings; frontal callus black, quadrate, touching eyes; median callus slender, usually isolated; frons at vertex bare and shiny but lacking ocellar tubercle; third segment of antenna with distinct forward-projecting tooth; eye pilose; thorax reddish brown with pale lines; abdomen reddish brown with three rows of pale whitish spots, these very large on first two tergites, much smaller on remaining tergites; wing hyaline, venation normal. Male with eye densely pilose, large and small facets not sharply differentiated, tooth of third segment of antenna smaller than in female; pale spots of abdomen reduced.

Comments: Of the three species of *Hamatabanus* listed by Philip (1965), only *H. carolinensis* has been collected in Tennessee. Females are blood feeders and will attack man and cattle. Collection dates range from 6 May to 25 June. The juvenile stages are unknown.

Genus HYBOMITRA Enderlein

In North America this genus is primarily northern in distribution. However, six species are known to occur in Tennessee, and at least four others may likely be collected in the future. Several of these species are very significant pests of livestock, particularly in the eastern portions of the state, but they usually do not attack man.

KEYS TO HYBOMITRA *SPECIES*

Females

Figures 9a, e, and f (p. 9) show several views useful when identifying *Hybomitra*.

1. Black species with first 3 abdominal segments mostly bright orange ---------- *cincta*
   Abdomen otherwise marked ---------- 2
2. Subcallus predominantly denuded and shining ---------- 3
   Subcallus pollinose ---------- 5
3. Abdomen reddish brown laterally; all crossveins spotted with brown ---------- *lasiophthalma*

Abdomen not extensively reddish brown laterally; wings not conspicuously spotted ----4

4. Basal plate predominantly orange; abdomen dull brown with median triangles and large sublateral spots, all indistinct; basal callus brownish, especially in the center; femora reddish brown ----*difficilis*

Basal plate with orange restricted to basal third; abdomen black, without sublateral spots, but with pale posterior borders that expand laterally (and sometimes medially as triangles); basal callus black; femora black----*nigricans*

5. Abdomen with a median row of conspicuous white triangles; sublateral spots absent----6

Abdomen otherwise marked ----7

6. Third antennal segment sharply bicolored, basal plate entirely orange, annuli black; wing heavily and rather uniformly darkened----*trispila*

Basal plate of third antennal segment partly black; infuscation of wing not uniform and not very dark----*sodalis*

7. Second palpal segment not slender, distinctly swollen basally ----*microcephala*

Second palpal segment slender, scarcely swollen basally----8

8. Femora, except base of hind femur, orange brown ----*minuscula*

Femora black ----9

9. Vertex with extensive pale areas; mesaepisternum yellowish in ground color, totally white haired; abdomen reddish laterally; antennal annuli greater than 0.55 mm in length ----*typhus*

Only ocellar area bare; mesaepisternum black, with abundant black hairs; abdomen predominantly black laterally; basal callus dark brown to black; antennal annuli less than 0.55 mm in length ----*pechumani*

Males

Figures 9b, e, and f (p. 9) show several views useful when identifying *Hybomitra*.

1. Stiff hairs along midline between eyes----2

No stiff hairs along midline between eyes ----3

2. Femora reddish brown; abdomen with indistinct sublateral spots; hind tibia with distinct black fringe----*difficilis*

Femora black; abdomen lacking isolated sublateral spots; hind tibial fringe only weakly developed ----*nigricans*

3. Black species with first 3 abdominal segments mostly bright orange----*cincta*

Abdomen otherwise marked ----4

4. Crossveins and fork of third longitudinal vein with distinct dark spots; abdomen laterally, broadly orange----*lasiophthalma*

Wing hyaline, tinted, or with fork only having a dark spot----5

5. Abdomen black, somewhat reddish laterally, with a median row of distinct white triangles; sublateral spots absent----6

Abdomen otherwise marked ----7

6. Third antennal segment sharply bicolored, basal plate orange, annuli black; line of demarcation between large upper eye facets and smaller lower facets distinct ----*trispila*

Basal plate of third antennal segment partly darkened; upper eye facets gradually merging with smaller lower facets ----*sodalis*

7. Abdomen broadly orange laterally, the median black area usually constricted on tergite 3; sublateral pale spots not conspicuous ----*minuscula*

Abdomen not broadly orange laterally; if paler laterally, the median dark area rather broad and not constricted on tergite 3; sublateral pale spots, if present, distinct and with little if any orange brown surrounding them ----8

8. Prescutal lobe black----*microcephala*

Prescutal lobe reddish ----9

9. Second palpal segment ventrally with only short sparse black hairs ----*typhus*

Second palpal segment ventrally with numerous long black hairs----*pechumani*

***Hybomitra cincta* (Fabricius).** Moderate to large (19 mm); predominantly black with the first 3 abdominal segments almost entirely encircled by orange; basal callus and median callus dark brown to black, broadly united; subcallus partly denuded; wing tinted pale brown. Male with pilose eyes; large and small facets not sharply differentiated.

Comments: This striking species is impossible to confuse with any other. In some mountainous areas in the eastern part of the state, *H. cincta* may be a common pest of livestock in late June and early July. Collection records are mostly restricted to the uplands, and range from 14 June to 27 July. Teskey and Burger (1976) reported collecting a single larva from wet organic soil at the margin of a small, slow-moving stream in a swampy woodland meadow.

***Hybomitra difficilis* (Wiedemann).** Moderate (13 mm); dark brown; subcallus denuded; basal callus brown, wider than high, usually separated from the rectangulate predominantly dull brown median callus; abdomen broadly brown in middle and reddish laterally, with indistinct median triangles, and usually at least suggestions of indistinct lateral spots; wing hyaline, costal cell yellow; eye almost bare. Male with large and small facets hardly differentiated; eye almost bare; erect hairs on midline between eyes.

Comments: From mid May through early June in upland areas of eastern Tennessee, *H. difficilis* can be one of the worst tabanid livestock pests and is one of the few horse flies that regularly attacks man (Figure 50). Many members of the Tabaninae tend to be less pestiferous in wooded areas than in pastures or pasture-woodland ecotones. *Hybomitra difficilis,* on the other hand, can be very pestiferous even in woodland areas 100 m or more from open pasture. Though its range extends south to northern Florida, it is most common in the central and southern Appalachians. Collection records range from 25 April to 3 July.

The larvae of this common pest species, as well as most aspects of its biology, are unknown. Larval surveys were conducted during 1977, 1978, and 1979 in upland areas where this species was extremely common. Searches of typical

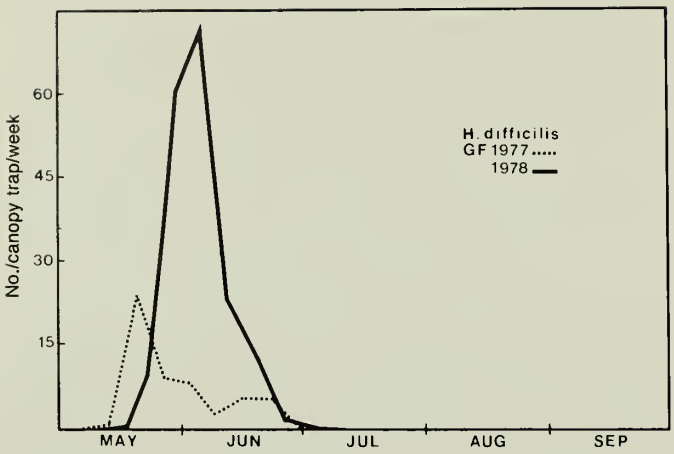


Figure 50. Seasonal abundance of *H. difficilis* (Grasslands Farm, Plateau Experiment Station, Crossville).

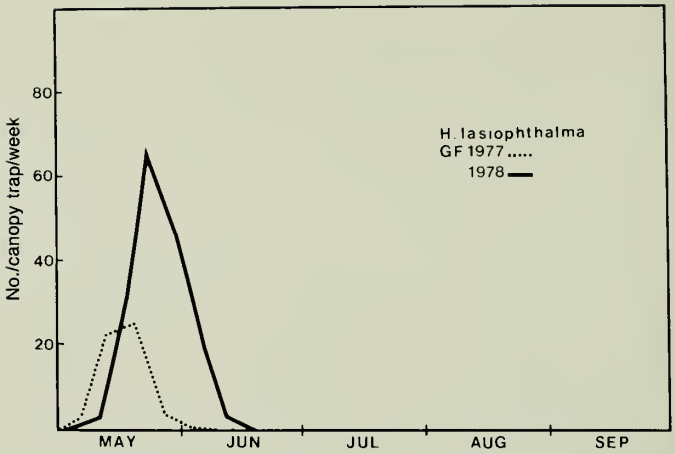


Figure 51. Seasonal abundance of *H. lasiophthalma* (Grasslands Farm, Plateau Experiment Station, Crossville).

tabanid larval habitats, such as mud at pond and stream edges, failed to turn up in a single larva of this species as did sampling in streams themselves. Further studies are needed. This species' larvae may well be terrestial, perhaps developing in deep organic material, rotted stump roots, or even at low densities in debris fairly close to the surface.

***Hybomitra lasiophthalma* (Macquart).** Moderate (14 mm); brownish and orange; basal callus orange brown, oval, not touching eyes, not united with short black elongate-oval median callus; subcallus partly denuded; abdomen broadly yellowish orange laterally with a dark brown to black median stripe, narrowest on tergites 2-4; wing hyaline except for infuscations at fork and on all crossveins, costal cell brownish. Male with eye facets of nearly uniform size; eye pilose.

Comments: *Hybomitra lasiophthalma* has the earliest flight period of Tennessee horse flies, and records range from 18 April to 29 June (Figure 51). Like *H. difficilis*, populations build rapidly, and *H. lasiophthalma* can be a severe livestock pest in May. It is widely distributed in Tennessee, but seems more common in the central and eastern regions. Teskey (1969) reported collecting larvae in a sphagnum bog, a bog-like backwater of a river, the margin of a woodland pool, a rotting log floating in a pond, and shrub-sedge marshes. On occasion, larvae of this species have been collected from spongy, saturated logs, typically well into the interior of the logs.

***Hybomitra microcephala* (Osten Sacken).** Moderate (14 mm); grayish black; basal callus brown, united with relatively slender dark brown median callus; subcallus pollinose; second palpal segment stout; abdomen black, brownish laterally, with three rows of pale spots; wing hyaline, costal cell yellowish; legs uniformly brown or reddish; eyes hairy. Male with eye facets of nearly uniform size; eyes hairy; prescutal lobe black.

Comments: This is another northern species for which the range extends southward along the Appalachians. It has not been found in Tennessee, but has been collected from southwestern Virginia and western North Carolina and will probably be found in the state. Teskey and Burger (1976) reported collecting a single larva from a well-decayed log lying in an oak-maple forest.

***Hybomitra minuscula* (Hine).** Small to moderate (11 mm); blackish brown, shiny; basal callus dark brown to black, subquadrate, broadly joined to dark brown elongate-attenuated median callus; second palpal segment very slender; abdomen blackish in middle, brownish to orange laterally, usually with three rows of indistinct pale spots; wing faintly tinted, usually darker along veins, costal cell yellowish; eyes hairy. Male with eye facets of nearly uniform size; eyes hairy.

Comments: This species breeds in bogs and is primarily northern in distribution and has not yet been found in Tennessee. Disjunct populations may exist, however, in small bogs in the eastern mountains. Teskey (1969) reported collecting larvae and noted that they are apparently restricted to sphagnum bogs, specifically only in loose saturated moss bordering the bog pond.

***Hybomitra nigricans* (Wiedemann).** Moderate (14 mm); brownish black; basal callus black, distinctly wider than high, isolated from broad median callus; subcallus denuded; abdomen blackish with indefinite pale posterior bands that expand laterally and sometimes medially to form faint triangles; wing hyaline, costal cell tinted; eyes hairy. Male with facets nearly uniform in size, eyes densely hairy; erect hairs on midline between eyes.

Comments: The range of *H. nigricans* is primarily coastal and sandhill areas of the southeastern U.S., but one record is from Stoneville, Mississippi. The species is common in Oklahoma. Western Tennessee might be within the range of this species. The immature stages are not known.

***Hybomitra pechumani* Teskey and Thomas.** Small to moderate (12 mm); blackish with grayish pattern of abdominal pale spots; basal callus black to dark brown, nearly as high as wide, subquadrate, usually separated from black to dark brown short narrow median callus; frons relatively broad, very slightly widened above; abdomen black dorsally,

sometimes faintly reddish laterally on tergite 2, with narrow grayish hind margins on tergites that give rise to distinct sublateral and median gray triangles, the latter usually equal in length or just shorter than the former; wing predominantly hyaline, costal cell lightly tinted brown, veins basally and at fork faintly tinted. Male with eyes densely pilose, large and small eye facets sharply differentiated; abdomen with distinct reddish areas laterally, which accentuate median black stripe on tergites 2 and 3; sublateral pale spots partly obliterated by reddish ground color; otherwise like female except darker.

Comments: Recently separated from *H. typhus, H. pechumani* is not yet known from Tennessee. Its distribution is primarily northern, but it has been collected in West Virginia, and its range may extend southward into the mountains of eastern Tennessee. The Tennessee record of *H. pechumani* reported by Teskey and Thomas (1979) has proven to be *H. typhus.*

***Hybomitra sodalis* (Williston).** Moderate (15 mm); blackish; basal callus black to brown, usually narrowly united to concolorous median callus; abdomen black with a median row of distinct grayish white triangles; wing tinted, especially anteriorly, costal cell yellow; eyes inconspicuously hairy; third antennal segment darkened at base. Male with eye facets nearly uniform in size; eyes hairy; sides of abdomen with some orange brown color.

Comments: *Hybomitra sodalis* is known only from upland areas in the eastern part of the state, where it can be quite common and a pest of cattle in late June or early July (Figure 52). Extreme collection records are 14 June and 3 August. Larvae have been collected from leaf debris and moss at the edge of mountain brooks, from beneath the bark of a log lying in a swampy area of pasture, and from wet mud of a spring-fed seepage area at the edge of a mixed hardwood forest. Teskey (1969) found larvae in many types of lentic wetland areas, except the more typical marshes; he noted that moss growing in woodland swamps was the most frequent habitat.

***Hybomitra trispila* (Wiedemann).** Moderate (14 mm); like *H. sodalis* except third antennal segment not darkened basally and wing more or less uniformly and darkly tinted.

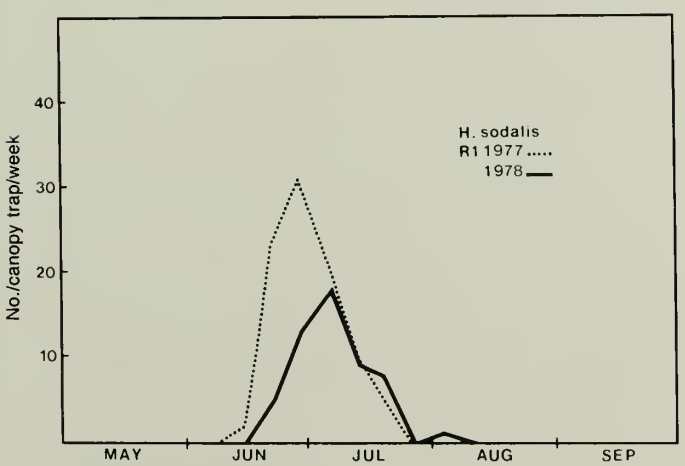


Figure 52. Seasonal abundance of *H. sodalis* (W.W. Stanley Cabin, Rafter, Monroe County).

Male with large and small facets differentiated; abdomen orange brown laterally; eyes hairy.

Comments: *Hybomitra trispila* seems to be more frequent in upland areas, but it has also been found at lower elevations. It is not common in the state. It resembles *H. sodalis,* and like *sodalis* will attack cattle. Collection records range from 11 June to 20 July. The immature stages are not known.

***Hybomitra typhus* (Whitney).** Small to moderate (12 mm); blackish with grayish pattern of abdominal pale spots; basal callus orange to brown (exceptionally black), wider than high, subquadrate, narrowly separated from black to dark brown (occasionally orange) oval median subcallus; frons relatively broad, very slightly widened above; abdomen predominantly black, somewhat orange laterally with narrow grayish hind margins on tergites from which arise rather broad flat median triangles on tergites 2-4 and rather oblique pale sublateral triangles on tergites 2-4 or 5; wing predominantly hyaline, costal cell lightly tinted brown, veins basally and at fork faintly margined. Male with eyes densely pilose; large and small eye facets sharply differentiated; otherwise pattern like female except darker.

Comments: This species is quite northern in its distribution, but one specimen has been collected from a canopy trap in Cumberland County on 30 May. Teskey (1969) described larvae and pupae under the name *H. typhus,* but these specimens have since proven to be *H. pechumani.* The immatures of true *H. typhus* were described by Teskey and Thomas (1979); all larvae were taken from saturated sphagnum.

Genus TABANUS Linnaeus

This is the most abundant genus in the Tennessee fauna and includes, along with species of *Hybomitra,* the insects typically termed horse flies. Species of this genus range from relatively small (10 mm) to very large (30 mm). Many of the species are major pests of livestock and a few species attack man.

KEYS TO TABANUS *SPECIES*

Females

Figures 9a, e, and f (p. 9) show several views useful when identifying female *Tabanus.*

1. Abdomen dorsally with a median longitudinal blackish area or row of blackish spots, the area or spots broader on posterior tergites and separating the contrasting orange to reddish brown lateral portions of tergites; wing spotted, a distinct spot at fork; femora black; subcallus pollinose; mesonotum dark; sublateral abdominal spots absent; second palpal segment distinctly swollen basally and not exceptionally elongate; first posterior cell decidedly narrowed, sometimes closed at wing margin; length usually exceeds 18 mm; frons narrow, 5 or more times as high as wide basally ---------- *abdominalis*

   Abdomen either with distinct median pale spots or triangles on one or more tergites, *or* unicolorous dorsally, *or* tergites predominantly unicolorous but some with narrow pale posterior transverse bands; usually disagreeing with at least one additional character ---------- 2

2. Abdomen either unicolorous or tergites with narrow pale posterior pollinose bands ---3
Abdominal tergite 2 or 3, and usually other succeeding tergites, with a middorsal pale triangle or spot, with or without pale sublateral spots ---14
3. Subcallus denuded; wing usually completely infuscated, dark brown, without a distinct spot at fork ---4
Subcallus pollinose; wing variable ---5
4. Basal callus considerably wider than high, usually at least upper third of gena denuded and shiny ---*atratus*
Basal callus typically square or slightly higher than wide; gena almost entirely pollinose ---*wiedemanni*
5. Mesonotum whitish pollinose ---*stygius*
Mesonotum brown to black ---6
6. Fork with a distinct dark cloud ---7
Fork without a distinct dark cloud ---13
7. Palpi dark brown to black ---8
Palpi pale to reddish brown ---10
8. Frons narrow, widened above; antenna mostly orange ---*proximus*
Frons of moderate width, sides nearly parallel; antenna mostly black ---9
9. Wing with dark spots, but membrane mostly hyaline ---*nigrescens*
Wing membrane uniformly dark or with veins broadly outined with dark infuscation ---*aranti*
10. All femora black; first posterior cell narrowed at wing margin; basal plate of third antennal segment lacking a strong dorsal tooth; thorax with a lavendar cast ---*gladiator*
Legs mostly yellowish or brown; first posterior cell not obviously narrowed, or if so, the basal plate of antenna bears a strong dorsal tooth; thorax otherwise colored ---11
11. Frons 3-4 times as high as wide basally, not widened above; dorsal tooth of basal plate projecting forward nearly to first annulus ---*imitans*
Frons narrow, about 6 times as high as wide basally, distinctly widened above; basal plate without an elongate dorsal tooth ---12
12. Clypeus, gena, and pleura brownish with concolorous hair ---*aar*
Clypeus, gena, and pleura gray to grayish-brown ---*turbidus*
13. Wing hyaline, costal cell dark brown; abdominal tergites usually with narrow grayish white posterior bands ---*americanus*
Wing uniformly and dilutely brown, costal cell yellow; occasionally with faint traces of middorsal abdominal triangles ---*calens*
14. Abdomen with a middorsal longitudinal pale stripe that may or may not be widened over posterior third of tergites ---15
Abdomen middorsally with longitudinal series of isolated pale triangles or spots ---30
15. Middorsal abdominal pale stripe nearly parallel sided; lateral pale spots usually forming a shorter, often irregular stripe parallel to median stripe on each side but these stripes sometimes are obsolete or broken into a series of separate spots ---16
Middorsal stripe obviously and regularly widened on posterior third of tergites; lateral pale markings series of separate, often roundish spots ---21
16. Prescutal lobe paler than mesonotum; frons widened above; basal plate typically longer than annulate portion; eye, in life or revived, with two diagonal purple bands ---17
Prescutal lobe concolorous with rest of mesonotum; frons nearly parallel sided; basal plate usually shorter than annulate portion; eye, in life or revived, with a single diagonal purple band ---19
17. Scutellum concolorous with thorax ---*lineola*
Scutellum reddish, sometimes faintly, on posterior margin ---18
18. Legs predominantly reddish; sublateral abdominal stripes nearly parallel sided ---*similis*
Femora of at least fore and hind legs darkened; sublateral stripes offset between second and third tergites ---*subsimilis*
19. Palpus, pleura, and costal cell yellow ---*quinquevittatus*
Palpus white, pleura grayish, costal cell dark yellow to brown ---20
20. Costal cell dark brown; pleura very pale, strongly contrasting with dark thoracic dorsum; frons ca. 4–4.5 times high as wide basally ---*fuscicostatus*
Costal cell dark yellow; pleura scarcely contrasting with thoracic dorsum; frons ca. 3.5–4 times as high as wide ---*mularis*
21. Eye distinctly pilose; second palpal segment very slender ---*exilipalpis*
Eye non-pilose or with only a few scattered hairs ---22
22. Dorsum of thorax covered with yellow hairs; longitudinal stripes lacking; abdominal stripes yellow; frons very narrow; antennal plate broad; costal cell colored ---23
Without this combination of characters ---24
23. Third antennal segment typically entirely yellow; femora pale, except possibly at extreme bases; palp white; face and pleura pale haired ---*pallidescens*
Third antennal segment brown to black; femora dark; palp yellow; face and pleura yellow haired ---*fulvulus*
24. Third antennal segment uniformly yellowish brown ---*zythicolor*
Annuli of third antennal segment black ---25
25. Frons narrow, distinctly widened above; basal plate very narrow; middorsal stripe grayish, not yellow ---*sackeni*
Frons broader, parallel sided or if narrow, not distinctly widened above; basal plate nearly as wide as long; middorsal stripe yellow ---26
26. Frons narrow, nearly parallel sided, 5 or more times high as wide basally; middorsal stripe yellow; basal plate slightly longer than wide; costal cell lightly infuscated ---*wilsoni*
Frons broader, less than 5 times as high as basal width; middorsal abdominal stripe gray, *or* basal plate slender and distinctly longer than thick ---27

27. Basal plate about as wide as long; costal cell heavily infuscated ---------- *longiusculus*
Basal plate longer than wide; costal cell hyaline or lightly infuscated ---------- 28
28. Second palpal segment much swollen basally; middorsal abdominal stripe broad ---------- *sagax*
Second palpal segment not much swollen basally; middorsal abdominal stripe narrow ---------- 29
29. Pale markings of abdomen yellowish brown, the sublateral spots plainly touching hind margins ---------- *sublongus*
Pale markings of abdomen grayish, the sublateral spots small and separated from hind margins ---------- *longus*
30. No pale median spot on second tergite but occasionally 2 small sublateral spots; fore tibia distinctly bicolored, white distally; venter of abdomen with an evident nearly parallel-sided dark stripe ---------- *trimaculatus*
Second abdominal tergite with a median pale spot--31
31. Abdomen with both median and sublateral pale spots ---------- 32
Abdomen with median pale spots only ---------- 39
32. Fork with a distinct dark spot ---------- 33
Fork without a dark spot ---------- 35
33. Wing with large brown maculations, these not confined to crossveins and furcation; lateral abdominal spots confined to posterior segments and often joined to median triangles ---------- *venustus*
Wing not so patterned and abdomen otherwise ------- 34
34. Median and sublateral spots broadly joined along posterior of abdominal tergites; frons narrow; basal callus higher than wide ---------- *cymatophorus*
Median and sublateral spots narrowly or not at all joined at posterior of abdominal tergites; frons broad; basal callus nearly square ---------- *reinwardtii*
35. Small species, usually less than 12 mm in length; frons widened above; costal cell hyaline ---------- 36
Larger species, usually 13 mm or more in length and differing in at least one other character ---------- 37
36. Median callus large; palpi not swollen basally or sharply pointed; eye, in life or revived, with 2 diagonal purple bands ---------- *pumilus*
Median callus slender; palpi swollen basally but with acute apex; eye, in life or revived with a single diagonal purple band ---------- *sparus milleri*
37. All wing veins margined with brown ---------- *gracilis*
Most, if not all, wing veins not margined with brown ---------- 38
38. First antennal segment swollen above; sides of subcallus with few hairs laterally; length generally 14-16 mm ---------- *fairchildi*
First antennal segment not swollen above; sides of subcallus without hairs; length generally 11-14 mm ---------- *marginalis*
39. Pale spot on second abdominal segment distinctly smaller than spots on third and fourth segments; scutellum with pale pile; fore tibia unicolorous ---------- 40
Pale spot on second segment not markedly smaller than those on two following segments ---------- 43
40. Abdomen black with very small median triangles ---------- *superjumentarius*
Abdomen usually brownish, at least in part; median triangles large ---------- 41
41. Frons very narrow, at least 6 times as high as width at base and widened above; middle and hind tibiae white, extreme apices darkened; first and second longitudinal veins margined with brown ---------- *moderator*
Frons less than 5 times as high as wide and scarcely widened above; middle and hind tibiae uniformly reddish brown; first and second longitudinal veins not margined with brown ---------- 42
42. Gena, pleura, and venter pale haired ---- *molestus molestus*
Gena, pleura, and venter brown haired - *molestus mixis*
43. No spot at fork ---------- 44
Fork with a conspicuous spot ---------- 48
44. Wing with a smoky tinge; costal cell heavily colored; large species, exceeding 21 mm; abdomen dark reddish brown with faint median triangles arising from faint posterior bands ----- *calens*
Wing hyaline; costal cell hyaline or slightly tinted; smaller species with conspicuous median triangles or relatively large species (19-21 mm) with abdomen bearing a broad dark median stripe on which there are small but typically distinct whitish median triangles ---------- 45
45. Relatively large species (19-21 mm); abdomen with a broad dark median stripe bearing small typically distinct white triangles; subcallus pollinose; first posterior cell only slightly narrowed apically ---------- *novascotiae*
Smaller species (11-19 mm); abdomen without an evident median dark band and bearing very distinct, moderately large white triangles; either subcallus at least partially denuded or first posterior cell extremely narrowed, often closed and/or petiolate ---------- 46
46. Tibiae unicolorous although fore tibia may be slightly paler at base; first posterior cell slightly or not at all narrowed at margin; subcallus thinly pollinose or denuded; usually under 15 mm ----- *nigripes*
At least fore tibia bicolored; first posterior cell much narrowed and may be closed or petiolate; subcallus pollinose; usually over 15 mm ---------- 47
47. Frons over 6 times as high as width at base; hind tibia uniformly yellowish white, barely darkened at apex; median triangle on second abdominal segment usually crossing segment and joining spot on first segment; first posterior cell usually closed, frequently petiolate ---------- *petiolatus*
Frons less than 6 times as high as wide; hind tibia often extensively dark toward apex; median triangle rarely crossing second abdominal segment; first posterior cell may be open or closed but rarely petiolate ---------- *melanocerus*
48. Fore tibia bicolored, basally pale with pale hair ------ 49
Fore tibia unicolorous or occasionally base somewhat brownish with orange hair ---------- 50
49. Frons narrow, 5 times or more as high as wide basally; first posterior cell normally closed, often

petiolate; all femora black ----------*limbatinevris*
Frons moderately wide, about 4 times as high as wide; first posterior cell normally open although often much narrowed at margin; at least middle femora brownish ----------*sulcifrons*

50. Basal plate with a long, forward-projecting tooth that reaches first annulus ----------*imitans*
Basal plate without a long, forward-projecting tooth----51

51. Clypeus, gena, and pleura brownish with concolorous hair; abdomen orange-brown with at most only faint suggestions of middorsal triangles, occasionally lateral margins dark---------*aar*
Clypeus, gena, and pleura gray to grayish brown with pale hair; abdomen with or without faint middorsal triangles, usually with lateral pale areas arising from pale posterior margins of each tergite ----------52

52. Wing veins margined with brown; frons height usually 6 or more times greater than basal width; third antennal segment mostly orange-------*turbidus*
Wing veins usually not margined or at most faintly margined with brown; frons height usually 5.5 or fewer times greater than basal width; third antennal segment mostly black ----------*equalis*

Males

Figures 9b, e, and f (p. 9) show several views useful when identifying male *Tabanus*.

1. Eye distinctly pilose ----------2
Eye bare or with but a few scattered hairs ----------5

2. Abdomen with a conspicuous parallel-sided median longitudinal pale stripe and similar irregular sublateral stripes dorsally; scutellum reddish, at least along posterior margin ----------*subsimilis*
Abdomen with a median longitudinal series of isolated pale spots or with a median stripe regularly widened on posterior third of tergites ----------3

3. Crossveins and fork with distinct dark spots-----*reinwardtii*
Wing without distinct dark spots ----------4

4. First antennal segment strongly swollen above; hair on eye rather sparse----------*fairchildi*
First antennal segment not strongly swollen above; hair on eye dense ----------*exilipalpis*

5. Abdomen unicolorous or with narrow indistinct pollinose bands ----------6
Abdomen with at least median markings ----------13

6. More or less entirely black species, including wing; frontal triangle denuded, shiny, and at least a little raised; fork of wing without a distinct dark spot ----------48
Otherwise colored, or if black, the frontal triangle is pollinose and wing has a distinct spot at fork ----------7

7. Fork without a distinct spot ----------8
Fork with a distinct spot or wing mostly black---------9

8. Wing dilutely infuscated, costal cell darker; hind tibial fringe black ----------*calens*
Wing hyaline, costal cell deep yellow; hind tibial fringe orange ----------*americanus*

9. Gena gray ----------*proximus*
Gena brown to black----------10

10. Rather uniformly brownish species including antennae ----------*aar* (in part)
Blackish-brown to black species ----------11

11. Wing almost completely black or with broad, heavy infuscation along all veins ----------*aranti*
Wing subhyaline----------12

12. Integument of thoracic dorsum brown, contrasting with black abdomen; wing membrane, except for spots, rather uniformly dilutely infuscated ----------*stygius*
Integument of thoracic dorsum dark brown to black, usually contrasting but slightly with black abdomen; apex of wing, except for spots, almost hyaline ----------*nigrescens*

13. Abdomen broadly orange laterally with conspicuous black median spots and no evident pale median markings; large and small eye facets little differentiated; femora black; wings spotted and first posterior cell narrowed or closed at wing margin ----------14
Abdomen with pale median markings and differing in at least one other character from the above--15

14. Thorax with a lavender tint, narrowly and inconspicuously striped; second palpal segment slender, at least 3 times as long as thick ----------*gladiator*
Thorax brown, broadly and conspicuously striped; second palpal segment about twice as long as thick ----------*abdominalis*

15. Abdomen with a longitudinal stripe that may or may not be somewhat widened at posterior margins of segments----------16
Abdomen with median markings not forming an uninterrupted stripe ----------28

16. Spots forming median abdominal stripe parallel sided; sublateral spots similar but often more irregular, rarely broken into roundish spots------17
Median spots widened at posterior margin of each segment so that stripe is not parallel sided; sublateral spots usually roundish----------21

17. Prescutal lobe usually paler than mesonotum; annulate portion of third antennal segment usually shorter than basal plate; costal cell usually hyaline ----------18
Prescutal lobe usually concolorous with mesonotum; annulate portion of third antennal segment as long or longer than basal plate; costal cell infuscated ----------19

18. Scutellum and thorax concolorous; hind femora usually dark ----------*lineola*
Scutellum reddish, sometimes faintly, on posterior margin; hind femora usually reddish ----------*similis*
(If scutellum partly reddish, upper eye facets enlarged, and femora dark, see *subsimilis*, couplet 2)

19. Palp, pleura, and costal cell deep yellow-----*quinquevittatus*
Palp and pleura grayish or white; costal cell variable----20

20. Abdomen rather broadly reddish laterally; pale pleura contrasting rather sharply with dark thoracic dorsum; large eye facets reaching occipital border with little reduction in size ----------*fuscicostatus*
Abdomen narrowly reddish laterally; dark gray

pleura not sharply contrasting with thoracic dorsum; small eye facets extend upward along eye margin nearly reaching ocellar area ----- *mularis*

21. Costal cell brown or dark yellow ---------- 22
Costal cell hyaline or pale yellow ---------- 23

22. Third antennal segment sharply bicolored, basal plate orange, annuli black ---------- *longiusculus*
Third antennal segment uniformly orange brown ---------- *zythicolor*

23. Hair and pollen of pleurae and face yellow; area of large and small eye facets scarcely differentiated ---------- *fulvulus*
Hair and pollen of pleurae and face pale, grayish; large and small eye facets distinctly differentiated ---------- 24

24. Third antennal segment entirely orange; long hairs on dorsum of thorax yellow ---------- *pallidescens*
Third antennal segment with at least annuli dark, long hairs on dorsum of thorax gray to black ---- 25

25. Coxae and femora blackish; costal cell hyaline; sublateral abdominal pale spots yellowish brown ---------- *wilsoni*
Coxae and femora yellowish brown; costal cell tinted or sublateral spots gray ---------- 26

26. Costal cell hyaline; short recumbent hairs of thoracic dorsum gray; sublateral abdominal spots gray ---------- *sackeni*
Costal cell tinted; short hairs of thorax often yellowish; sublateral abdominal spots usually yellow or with a yellowish tint ---------- 27

27. Median abdominal stripe broad; face below eyes with many black hairs, beard yellowish white; second palpal segment stout, yellowish brown with many black hairs ---------- *sagax*
Median abdominal stripe narrow; face with almost no black hairs, beard pale gray; second palpal segment relatively slender, pale yellowish white with few black hairs ---------- *sublongus*

28 Frontal triangle bare and somewhat protuberant; abdominal triangles sometimes indistinct; small, chunky species usually under 13 mm -------- *nigripes*
Frontal triangle pollinose ---------- 29

29. Abdomen with median spots or triangles and at least some segments with sublateral spots ---------- 30
Abdomen with median spots or triangles; no distinct sublateral spots, although some segments may be paler laterally ---------- 35

30. Wing mottled with brown, the spots not confined to crossveins or furcation; tergites 2-4 with posterior white bands nearly obliterating the median and sublateral spots, but the spots distinct on tergite 4 ---------- *venustus*
Not with this combination of characters ---------- 31

31. Fork and crossveins margined with brown --- *cymatophorus*
Wing entirely hyaline or with a faint spot at fork only, or all veins faintly margined with brown ---- 32

32. All veins margined with brown ---------- *gracilis*
Wing veins not margined, at most a faint spot at fork ---------- 33

33. Fore tibia entirely black; sublateral spots very large often crossing second and third segments; third antennal segment black ---------- *marginalis*
Fore tibia paler at base; sublateral spots smaller; third antennal segment rarely entirely black ----- 34

34. Tibiae same color as reddish brown to brown femora or slightly paler basally; antenna yellowish, often with annulate portion somewhat darker; basal plate 2.5–3 times as long as wide; occipital tubercle prominent and often projecting above level of eyes ---------- *pumilus*
Tibiae distinctly paler than dark femora except apex of fore tibia, which is dark; antenna uniformly dull brownish; basal plate about twice as long as wide; occipital tubercle inconspicuous and compressed, usually not reaching level of eyes ---------- *sparus milleri*

35. Pale spot on second abdominal segment much smaller than those on third and fourth segments or absent ---------- 36
Pale spot on second abdominal segment not markedly smaller than those on two following segments ---------- 40

36. Abdomen blackish with large white triangles not arising from bands on third to fifth segments; fore tibia bicolored ---------- *trimaculatus*
Not with this combination of characters ---------- 37

37. Middle and hind tibiae largely white; abdominal triangles arising from pale bands ---------- *moderator*
All tibiae dark reddish brown ---------- 38

38. Abdominal triangles very small, not arising from bands; scutellum concolorous with thorax; area of large eye facets occupying about half of total eye area and sharply differentiated ---------- *superjumentarius*
Abdominal triangles moderate in size, often arising from bands; scutellum white pollinose, contrasting with dark thorax; area of large facets occupying about two-thirds of total area but not sharply demarcated ---------- 39

39. Face and cheeks gray pollinose; abdominal spots arise from pale bands that may cover basal half of third and fourth segments; venter with wide gray bands ---------- *molestus molestus*
Face and cheeks mostly brown pollinose; abdominal bands, if present, very narrow on dorsum and venter ---------- *molestus mixis*

40. No spot at fork ---------- 41
Fork with a conspicuous spot ---------- 44

41. Little differentiation in size of eye facets; line of demarcation indistinct; large species with very small median triangles and dark yellow legs and antennae ---------- *calens*
Large eye facets distinctly set off from small facets; third antennal segment at least partly dark; size variable ---------- 42

42. Abdomen with a median dark area on which are found small whitish triangles; second palpal segment yellowish brown ---------- *novascotiae*
Abdomen with median area not noticeably darker than lateral areas; median triangles distinct and moderately large; second palpal segment yellowish white to white ---------- 43

43. Median triangle crosses second abdominal segment; hind tibia usually completely pale; large eye facets occupy about half of total area------*petiolatus*
Median triangle does not cross second abdominal segment; hind tibia darkened at apex; large eye facets occupy about two-thirds of total area ----------*melanocerus*

44. Abdomen, thorax, legs and antennae rather uniformly brownish; abdominal spots evanescent, apparently not arising from bands; wing markings pale----------*aar*(in part)
More contrastingly marked species or abdominal triangles arising from bands ----------45

45. Median abdominal spots not arising from bands; basal plate with a long forward-projecting tooth ----------*imitans*
Median abdominal spots arising from bands; basal plate without a long tooth ----------46

46. Legs rather uniformly yellowish to dark brown and fore tibia not paler at base ----------*turbidus*
Legs with femora darker than tibiae and fore tibia paler at base----------47

47. Pale median abdominal triangles conspicuous; middle femor often brownish; wing membrane lightly tinted----------*sulcifrons*
Pale median abdominal triangles obsolete but with heavy median black spots; all femora deep black; wing heavily tinted especially anteriorly ----------*limbatinevris*

48. Both frontal triangle and gena denuded and shiny; third antennal segment with a rather long tooth ----------*atratus*
Gena pollinose; third antennal segment without a long tooth ----------*wiedemanni*

***Tabanus aar* Philip.** Large (22 mm); brown with pale grayish pattern; basal callus brown, higher than wide, a little rounded above, narrowly united with relatively slender median callus; frons narrow, a little widened above; abdomen brown with a median row of small indistinct grayish triangles; wing faintly infuscated, darker along veins. Male unknown.

Comments: Perhaps due in part to its crepuscular and nocturnal habits (Pechuman 1973), this species is rarely collected in Tennessee. Only two records are known from Shelby County on 21 June and Cumberland County on 21 July. The latter specimen was decribed by Pechuman (personal communication) as the "dark form of *aar*," which he thought could be an extreme variant or an undescribed species. The immature stages are not known.

***Tabanus abdominalis* Fabricius.** Relatively large (21 mm); orange to reddish brown; basal callus dark brown, narrowly united with slender median callus; frons narrow, widened above; abdomen with a median row of dark spots, these wider posteriorly, at most with only indefinite indications of pale median triangles; fore tibia pale at base; femora black; wing heavily tinted with dark spots at fork and crossveins, costal cell dark yellow; eyes bare. Male with large and small eye facets but these not sharply differentiated; eyes bare.

Comments: This species is part of the difficult *sulcifrons* complex, but can usually be separated by the very narrow frons, black femora, bicolored tibiae, and more distinct thoracic stripes. *Tabanus abdominalis* also usually lacks abdominal triangles, though faint ones may be present. The peak flight period for this species is usually early July, though collection records range from 21 June to 12 August. It is a pest of cattle. The immature stages are not known. The larvae described as *T. abdominalis* (Goodwin 1973b) have proven to be larvae of *T. limbatinevris,* a species not recognized at the time of the description.

***Tabanus americanus* Forster.** Large (27 mm); reddish brown; basal callus orange brown to dark brown, narrowly joined to slender median callus, frons narrow, parallel sided; abdomen with narrow, pale hind margins of segments; wing hyaline, costal cell dark brown; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This huge fly is usually not present in large numbers in Tennessee and it does attack livestock. It has a long flight period and has been collected from 31 May to 31 August. Some specimens approach 30 mm in length, making this the largest tabanid in North America. Tidwell (1973) reported collecting larvae of this species from decaying logs in bottomland mixed hardwood forest in areas subject to occasional flooding. Jones and Anthony (1964) reported taking larvae from the muddy margin of a shallow pool. Two larvae were collected in Tennessee in habitat similar to that noted by Tidwell.

***Tabanus aranti* Hays.** Large (21 mm); nearly black; basal callus brown, higher than wide, rounded above, united with slender median callus; frons narrow, a little widened above; abdomen black, without pattern, but more or less entirely covered by a bluish white pollinosity or bloom; wing heavily infuscated brown, at a minimum including costal cell and broad margins along all veins, sometimes including entire wing; first posterior cell somewhat narrowed. Male with areas of large and small eye facets sharply differentiated; otherwise like female except abdominal bloom reduced to traces.

Comments: *Tabanus aranti* closely resembles the more commonly collected species *T. atratus*. It will attack cattle and has been taken from 17 June to 26 July. Most eastern U.S. specimens determined as *colon* or *atripennis* are actually *aranti* (Pechuman, personal communication). Goodwin (1973b) reported taking larvae of this species from stream habitats; larvae were associated with aquatic vegetation such as watercress, cattail, and water lilies. Tidwell (1973) reported collecting larvae from the margins of a shallow beaver pond in a hardwood forest.

***Tabanus atratus* Fabricius.** Large (24 mm); black; basal callus black, wider than high, the median callus a black attenuated projection; frons relatively broad, parallel sided; subcallus denuded, shiny black; wing dark brown to black; eyes bare. Male with large and small facets sharply differentiated; eyes bare.

Comments: This large species is probably the "blue-tail fly" of folk song fame. It approaches *T. americanus* in size and is extremely widespread in Tennessee, though it is seldom present in large numbers. It has been collected as early

as 9 May and as late as 19 September and will readily attack cattle and horses. The attractive larvae, white with black pubescent mottling (Figure 3, p. 3), may be found in a variety of pond edge or creek mud situations, but have also been found in fairly large numbers in floating fecal mats on a dairy waste lagoon. Many authors (e.g., Teskey 1969; Tidwell 1973) have reported collecting larvae of this species. Larval habitats have included a wide variety of areas such as mud at the margins of streams, ponds, and lakes; crevices in decaying logs; spaces beneath the bark and wood of decaying logs; accumulations of silt and vegetation at the margins of all types of freshwater areas; and mud in roadside ditches and borrow pits where inundation is seasonal. Larvae have been collected throughout the state in habitats similar to those noted above.

***Tabanus calens* Linnaeus.** Large (24 mm); dark brown and black; basal callus dark reddish, tapering to an elongate slender median callus; frons narrow, parallel sided; thorax brown with indistinct reddish lines; abdomen blackish, sometimes with faint pale median triangles; wing tinted yellowish brown, costal cell darker; eyes bare. Male with little differentiation in large and small eye facets; eyes bare.

Comments: The primary flight period for this large species is mid to late August but it has been taken from 12 July to 22 September. It is widespread in the state, quite common in some areas, and readily attacks cattle and occasionally a human. Larvae have been found on a hillside seepage area and in root mats on a moist, well-drained forest slope. Teskey (1969) reported that a single larva identified as *T. calens* on the basis of comparisons with preserved larvae reared from eggs was collected from damp, lowland pasture sod.

***Tabanus cymatophorus* Osten Sacken.** Moderate to large (19 mm); brown with pronounced grayish white pattern; basal callus brown, higher than wide, narrowly united with slender median callus; frons narrow, slightly widened above; abdomen with three rows of large grayish white triangles, these rather broadly united at posterior border of tergites; wing nearly hyaline, with spots at fork and crossveins, costal cell not darkened; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: Records for *T. cymatophorus* range from 20 July to 31 August and are restricted to the western counties. It is not commonly collected. Thompson (1978b) reported taking a larva from the marginal mud of a woodland pond.

***Tabanus equalis* Hine.** Moderate to large (19 mm); brown with grayish pattern; basal callus reddish brown, rather broadly connected to wide elongate median callus of same color; frons moderate in width, widened above; abdomen reddish brown with a median row of distinct grayish triangles; wing hyaline, fork and crossveins faintly margined with brown, costal cell not darkened; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This species is apparently limited to the western portion of the state, where it has been collected as early as 5 May and as late as 18 July. It can be fairly common and will attack cattle. Schomberg and Howell (1955) reported larvae from well-drained soil beneath elm trees in Oklahoma.

***Tabanus exilipalpis* Stone.** Small to moderate (11.5 mm); dark brown with pale brownish pattern; basal callus subquadrate, orange brown; median callus a slender linear extension from basal callus; second palpal segment very slender; abdomen dark brown with a pale brownish median stripe or row of united triangles and distinct sublateral spots; eyes pilose. Male with eyes distinctly pilose, large and small facets not sharply differentiated; pattern and coloration like female except darker; body, especially thorax, much hairier than female.

Comments: This species is not common in the state. Collections range from 25 May to 15 June. The immature stages are not known.

***Tabanus fairchildi* Stone.** Moderate (14 mm); blackish brown with grayish white pattern; basal callus dark brown to black, distinctly connected to rather short, broad median callus; frons moderately broad, widened above; antennae black, basal segment swollen above; abdomen blackish with three rows of grayish white spots; wing hyaline; eyes bare or with short sparse hairs. Male with large and small eye facets but these not sharply differentiated.

Comments: *Tabanus fairchildi* has been collected from 22 June to 30 July, with most apparently active in early and mid July. Larvae are truly aquatic and are found in streams and rivers. Teskey (1969) reported collecting larvae from stones and gravel in riffle areas of a stream. Tidwell (1973) reported finding larvae beneath a layer of moss covering a partially submerged log in a beaver dam. Larvae have been collected from riffle areas of streams throughout the state.

***Tabanus fulvulus* Wiedemann.** Moderate (14 mm); yellowish to orange; basal callus dark brown to black, higher than wide, usually not connected to elongate oval median callus; frons narrow, nearly parallel sided; basal plate of third antennal segment orange, annuli black; thorax without obvious pattern; abdomen with a median row of contiguous yellow triangles and sublateral spots; eyes bare. Male with large and small facets but these not distinctly differentiated; eyes bare.

Comments: This beautiful fly, with brilliant green eyes and bright orange antennae, is one of the most common and widespread horse flies in Tennessee. It readily attacks the legs and lower body of cattle and horses, and can be very pestiferous from late June through mid July (Figure 53). Snow et al. (1957) reported it may occasionally attack man. Collection records range from 10 May to 31 August. Tidwell and Tidwell (1973) reported collecting larvae from well-drained soil of a mixed pine-hardwood forest.

***Tabanus fuscicostatus* Hine.** Small (11.5 mm); brown with yellowish pattern; basal callus yellowish brown, square or slightly higher than wide, usually not connected to small oval medium callus; frons moderately broad, nearly parallel sided; thorax dark brown, usually with paler longitudinal stripes; abdomen dark brown with a parallel-sided median yellowish stripe and usually small faint sublateral spots; wing hyaline, costal cell brown; eyes bare. Male with large and small facets of eyes sharply differentiated; eyes bare; body pattern essentially like female but dark areas are much paler, especially abdomen and legs.

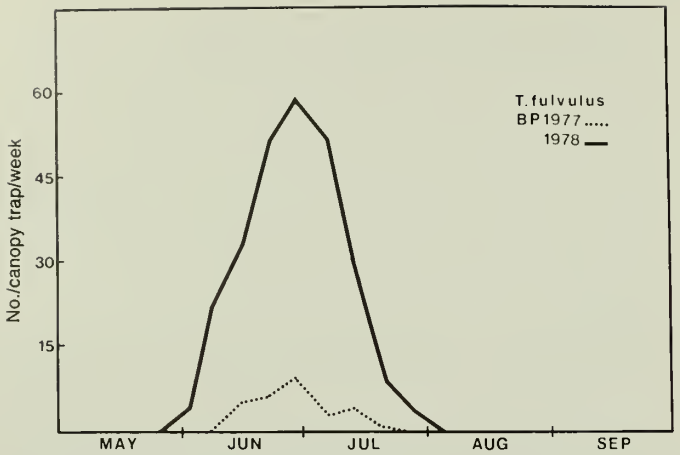


Figure 53. Seasonal abundance of *T. fulvulus* (W.W. Stanley Farm, Ball Play community, Monroe County).

Comments: This species has been reported from Shelby County, but the collection record is not certain. Nonetheless, it may well be found in the western counties. The immature stages have been taken from poorly drained forest soil in bottomland hardwood forest areas (Tidwell and Tidwell 1973).

***Tabanus gladiator* Stone.** Large (23 mm); predominantly orange brown; basal callus brown, narrowly connected to long slender attenuate median callus; frons narrow, very slightly widened above; second palpal segment very long and slender; thorax with a lavender cast; abdomen orange brown, sometimes with dark median anterior spots and pale posterior triangles on some tergites; wing tinted yellowish brown, fork and crossveins margined in darker brown; costal cell brown; first posterior cell nearly closed; eyes bare. Male with large eye facets only slightly larger than small eye facets, not sharply differentiated; eyes bare.

Comments: Pechuman (personal communication) has seen three *T. gladiator* specimens collected from 28 July to 5 September in Morgan County, but we have not collected this species. It is part of the difficult *sulcifrons* group, but its lavender-tinted thorax, dark legs, narrow frons, and saber-shaped palpi are distinctive. Goodwin (1973b) reported collecting larvae from the upper inch of mud and organic debris at the margins of ponds and lakes.

***Tabanus gracilis* Wiedemann.** Moderate (14 mm); brown; basal callus yellowish brown tapering to a concolorous median callus; frons moderately broad, parallel sided; abdomen yellowish brown with three rows of paler grayish triangles, the medians usually not attaining anterior margin, the sublaterals with inner margins forming a more or less straight line; wing predominantly hyaline but costal cell and margins of veins tinged brown; eyes bare. Male with large and small eye facets sharply differentiated, eyes bare.

Comments: This species is not known from the state, but it is found in the North Carolina Piedmont and may possibly be present in Tennessee. The immature stages are not known.

***Tabanus imitans* Walker.** Large (22 mm); dark reddish brown; basal callus brown, a little higher than wide, rounded above, narrowly united to slender, elongate median callus; abdomen dark reddish brown with a median row of small, pale white triangles; wing hyaline, costal cell dark brown, fork and crossveins margined in brown, first posterior cell somewhat narrowed; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This species has been collected only from Hardin County, 5 July. Goodwin (1976c) reported taking three larvae, two from sphagnum moss at the margin of a lake and one from moist soil about 0.5 m from the edge of the same lake; the latter larva was found about 25 cm deep.

***Tabanus limbatinevris* Macquart.** Moderate to large (17 mm); brown with grayish white pattern; basal callus brown to black, higher than wide, rounded above, narrowly united with slender median callus; frons narrow, parallel sided to a little widened above; abdomen brown with pale hind and side margins on tergites and a row of distinct median triangles on tergites 2-6, these equilateral or a little longer than broad; wing predominantly hyaline but with distinct brown spots on crossveins and fork, costal cell brown, veins margined a paler brown than spots on crossveins, first posterior cell at a minimum greatly narrowed, usually closed and often petiolate. Male with large and small eye facets sharply differentiated; otherwise like female except pattern somewhat darker and first posterior cell usually narrowed but rarely closed or petiolate.

Comments: Pechuman (1981) has reseparated *T. limbatinevris* from *T. sulcifrons*. It appears to be widespread in Tennessee, and further examination will undoubtedly yield more specimens that have been determined as *sulcifrons* or *abdominalis*. The frons is more narrow than that of *sulcifrons*, the abdomen is less orange, and the first posterior cell, which is nearly always open in *sulcifrons*, is closed and often petiolate in *limbatinevris*. Pechuman et al. (1983) present statistics that help separate *sulcifrons, abdominalis,* and *limbatinevris* on the basis of body length, frons ratio, and closure of the first posterior cell.

Confirmed records are known from 6 July to 8 September, and one specimen from Lake County was labeled "June." It will attack cattle. Goodwin (1973b) reported collecting larvae of this species (as *T. abdominalis*) from the upper 5 cm of mud at the margin of a slough in a mixed bottomland/hardwood forest. Teskey (1969) also reported collecting larvae (as *T. sulcifrons*) from wet grassy banks of a shallow drainage ditch that traversed a predominantly maple woodlot.

***Tabanus lineola* Fabricius.** Moderate (13 mm); dark brown to black with grayish white pattern; basal callus dark brown to black, higher than wide, rounded above, narrowly united to slender elongate median callus; frons narrow, distinctly widened above; abdomen blackish with a parallel-sided white median stripe and white sublateral spots that are usually united to form irregular sublateral stripes; wing hyaline; scutellum entirely dark; hind femora predominantly dark; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: A melanistic form of *T. lineola* is extremely widespread and common in Tennessee. It is a pest of cattle (particularly the legs and face) in many areas and may occasionally attack man. Populations of this species usually peak in late June or July (Figure 54), but there is also some evi-

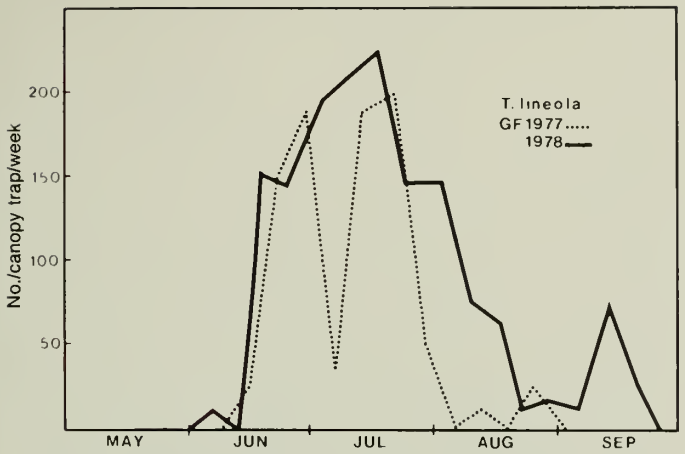


Figure 54. Seasonal abundance of *T. lineola* (Grasslands Farm, Plateau Experiment Station, Crossville).

dence of a partial second brood in early September. Collection records range from 20 May to 2 October. Like *T. atratus*, larvae of *T. lineola* have been collected from a wide variety of wet areas including mud at the margins of ponds and lakes, wooded swamps, and alder swamps; larvae also have been found in sphagnum bogs, beneath the bark of logs in or at the margins of ponds and streams, moist forest soils, and intermittently flooded ditches (Teskey 1969; Tidwell 1973). Many larvae of this species have been collected throughout the state in habitats such as those noted above.

***Tabanus longiusculus* Hine.** Small to moderate (12.5 mm); dark brown with grayish pattern; basal callus orange brown, distinctly higher than wide, typically united with relatively brown oval median callus by a slender line; abdomen predominantly dark brown, paler laterally, with slender median row of grayish contiguous triangles and isolated sublateral spots; wing hyaline, costal cell yellowish; basal plate of third antennal segment about as long as combined length of terminal annuli; eyes bare. Male with large and small eye facets moderately differentiated; eyes bare.

Comments: *Tabanus longiusculus* has been collected only in two western Tennessee counties, Benton and Carroll, from 21-23 August. The immature stages are not known.

***Tabanus longus* Osten Sacken.** Moderate (14 mm); dark brown with grayish pattern; basal callus subquadrate, yellowish to dark brown, united by a slender line to moderately broad oval median callus; frons moderately wide, parallel sided; abdomen dark brown with a pale grayish median row of contiguous triangles and usually oval isolated yellowish sublateral spots; wing hyaline, third antennal segment slender, with little indication of a tooth on basal plate; eyes bare. Male unknown.

Comments: This species is part of a difficult group comprised of *T. longus*, *T. sackeni*, and *T. sublongus* in Tennessee. Pechuman (1973) has pointed out that characters that usually hold in other *Tabanus* spp. seem quite plastic in the *longus* group. The larvae and male of *T. longus* are unknown. Records for *T. longus* are limited to upland areas in the eastern part of the state and range from 2 June to 7 September. In one area it is a minor cattle pest and has an apparent population peak in mid August. It will sometimes attack man.

***Tabanus marginalis* Wiedemann.** Moderate (13 mm); blackish brown with whitish pattern; basal callus yellowish to dark brown, about as high as wide, rounded above, narrowly united with short slender median callus; frons moderately wide, parallel sided; abdomen with rows of small whitish median triangles and much larger whitish sublateral spots; wing hyaline; eyes bare. Male with large and small eye facets distinctly differentiated; eyes bare.

Comments: This species is generally more northern, but disjunct populations occur southward along the Appalachian mountain chain (Pechuman 1973). It has been collected in two eastern Tennessee locations, and records range from 11 May to 2 June. Teskey (1969) reported collecting many larvae of this species. They were found in saturated or nearly saturated soils of most types of wetland areas examined including silty and sandy banks of streams and ponds having little vegetative cover, marshes and swamps of various types in areas where organic matter content varied widely, and completely organic soil situations in sphagnum bogs.

***Tabanus melanocerus* Wiedemann.** Moderate (17 mm); dark brown to black with whitish pattern; basal callus dark brown, distinctly higher than wide, narrowly united with slender median callus; frons narrow, very slightly widened above; abdomen with narrow whitish hind margins and a row of distinct whitish median triangles, that of second tergite sometimes narrowly attaining anterior margin; wing hyaline, first posterior cell narrowed, sometimes closed but not petiolate. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: *Tabanus melanocerus* is widespread in Tennessee and has been taken from 7 June to 31 August, with peak populations occurring from late June through mid July (Figure 55). It will attack cattle.

Specimens of *T. melanocerus* can be very difficult to separate from *T. petiolatus* in eastern Tennessee, as the latter species tends to blend with it in terms of characters such as size, frons width, and wing venation. In western Tennessee the two species separate very well.

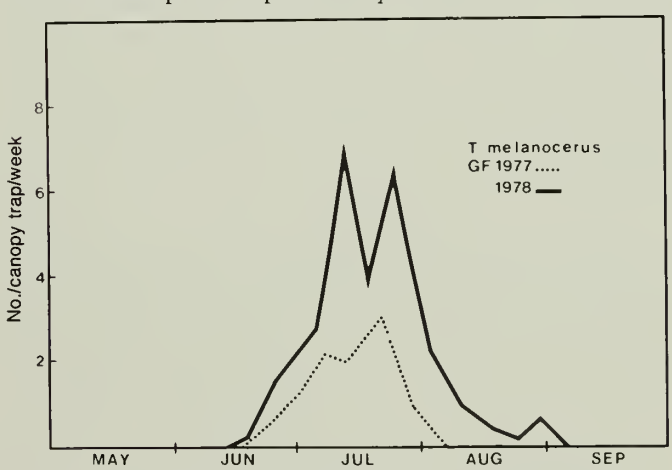


Figure 55. Seasonal abundance of *T. melanocerus* (Grasslands Farm, Plateau Experiment Station, Crossville).

Teskey (1969) reported collecting larvae from the margins of streams, and Tidwell (1973) found them in small, sandy-bottomed streams in pine and upland hardwood forests and in a beaver dam. Larvae have been collected from wet organic mud at the margins of lakes and in similar areas along the margins of forest streams.

***Tabanus moderator* Stone.** Relatively large (19 mm); dark brown with whitish pattern; basal callus orange brown, about twice as high as wide, rounded above, distinctly united with elongate slender median callus; frons narrow, widened above; thorax dark brown with yellowish gray stripes, scutellum white; abdomen with narrow whitish hind margins and a row of broad white median triangles, that of tergite 2 decidedly smaller than those of tergites 3 and 4; wing hyaline to faintly tinted; fork, crossveins, and longitudinal veins margined in pale brown, costal cell pale brown; eyes bare. Male with middle and hind tibiae white except at extreme apices; hairs on all coxae and pleurae white; large and small facets rather sharply differentiated, eyes bare.

Comments: This species is known from several eastern Tennessee counties, where it has been collected from 31 May to 26 July. It seems most common in mid to late June. Blood feeding activity for this species is markedly crepuscular, and considerable numbers have been observed feeding on cattle at dusk in the eastern Tennessee mountains. The immature stages are not known.

***Tabanus molestus* Say.** Moderate to large (18 mm); dark brown to black with grayish white pattern; basal callus brown, slightly higher than wide, rounded above, distinctly united with rather broad elongate median callus; frons rather broad, slightly widened above; thorax dark brown with whitish lines, scutellum whitish; abdomen with narrow pale whitish hind margins, a median row of distinct whitish triangles, that on tergite 2 distinctly smaller than those on tergites 3 and 4; wing nearly hyaline, fork and crossveins faintly margined in brown, costal cell brown; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: Both *T. m. molestus* and dark-haired variety, *T. m. mixis,* are fairly common and widespread in the state. Records for *m. molestus* range from 27 May to 27 July (Figure 56) and for *m. mixis* from 24 May to 9 August. Peak activity for both forms is late June and early July, and they are often sympatric. We have noticed no intergradation, and these probably should be considered color forms rather than subspecies. Some crepuscular feeding activity has been noted for both forms on cattle. The immature stages are not known.

***Tabanus mularis* Stone.** Small (10 mm); olive green and blackish with grayish yellow pattern; basal callus dark brown to black, slightly higher than wide, usually not connected to small oval median callus; frons moderately broad, parallel-sided; thorax olive green without pattern; abdomen blackish with a parallel-sided yellowish gray median stripe and hints of faint sublateral spots; wing hyaline, costal cell brownish; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This species closely resembles *T. quinquevittatus.* It is widespread in the western and central portions

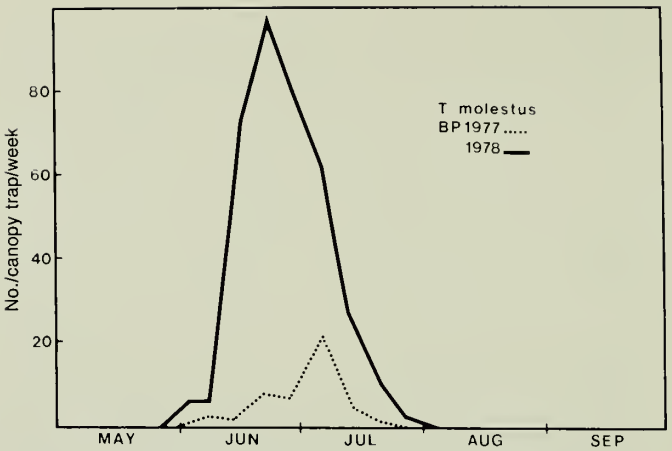


Figure 56. Seasonal abundance of *T. molestus* (W.W. Stanley Farm, Ball Play community, Monroe County).

of the state, but is seldom taken in the eastern counties. Collection records range from 20 May to 19 September. Though known to attack cattle, *T. mularis* is not usually found in large numbers. The immature stages are not known.

***Tabanus nigrescens* Palisot de Beauvois.** Large (22 mm); black; basal callus dark brown, higher than wide, slightly constricted dorsally, distinctly united with rather broad elongate median callus; frons broad, nearly parallel sided; thorax and abdomen black dorsally, without pattern; wing pale yellowish, fork and crossveins marked by dark spots, costal cell dark, first posterior cell narrowed; eyes bare. Male with large and small facets of eyes sharply differentiated; body, especially thorax, more brownish than female; eyes bare.

Comments: *Tabanus nigrescens* has been collected in nine counties of eastern and western Tennessee, and has never been found more than a few times during a season in any locality. Records range from 28 June to 3 August. Goodwin (1973b) reported taking larvae from beneath the bark of a partially submerged log in a spring-fed marsh and from wet mud near the edges of open marshes, a lake, and woodland streams. Tidwell (1973) reported taking larvae from a beaver pond.

***Tabanus nigripes* Wiedemann.** Small to moderate (12 mm); blackish brown with grayish pattern; basal callus yellowish brown to black, higher than wide, rounded above, distinctly united with slender median callus; frons narrow, slightly widened above; subcallus at least partly denuded; abdomen blackish brown with a median row of grayish triangles; wing hyaline, sometimes faintly tinted at fork and crossveins, costal cell yellow; eyes bare. Male with large and small eye facets sharply differentiated; frontal triangle denuded, prominent; eyes bare.

Comments: The primary flight period for *T. nigripes* is mid June to early July, but adults have been collected from 2 June to 5 September (Figure 57). In some areas it can be a pest of cattle. Larvae have been taken from sphagnum bogs or cranberry bogs, or bog-like backwaters of streams having a layer of moss and peat over sand (Teskey 1969) and at the

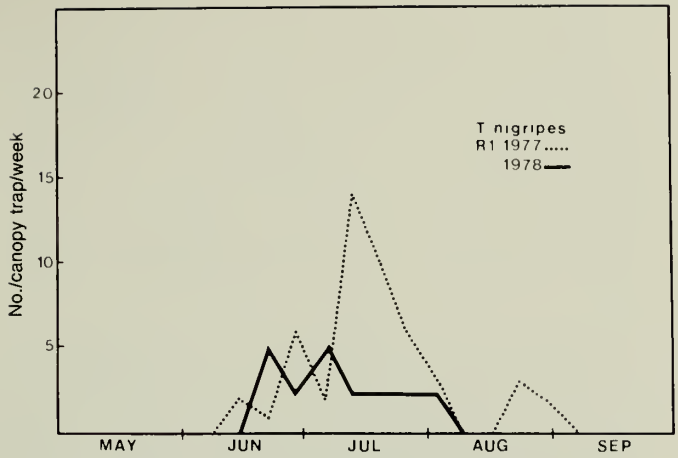


Figure 57. Seasonal abundance of *T. nigripes* (W.W. Stanley Farm, Ball Play community, Monroe County).

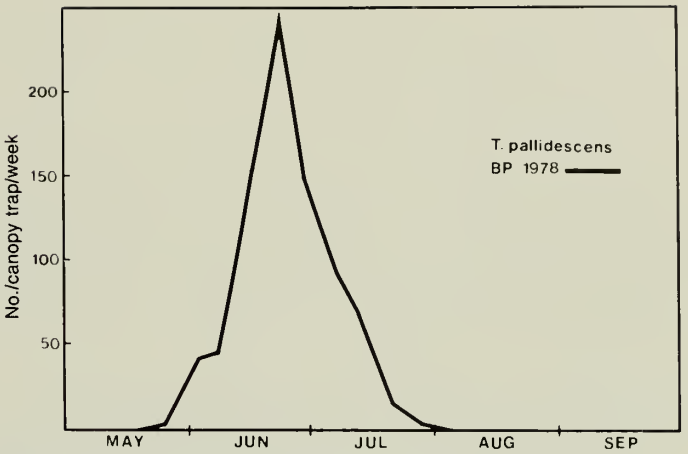


Figure 58. Seasonal abundance of *T. pallidescens* (W. W. Stanley Farm, Ball Play community, Monroe County).

margin of a small pond in mixed pine-hardwood forest (Tidwell 1973).

***Tabanus novascotiae* Macquart.** Relatively large (20 mm); reddish brown with whitish pattern; basal callus brown to black, higher than wide, rounded above, distinctly united with slender median callus; frons broad, parallel sided; abdomen with a dark median longitudinal band ranging from distinct to obsolete and with a median row of small whitish triangles; wing hyaline or faintly yellowish, costal cell yellow; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This species breeds in bogs, has a northern distribution, and is not known from Tennessee. Disjunct populations might exist, however, in the few bogs that are found in the eastern mountains. Teskey and Burger (1976) reported collecting larvae from sphagnum moss in a bog and from moss in a wet roadside ditch.

***Tabanus pallidescens* Philip.** Except for the characters noted in the keys to species, this species is essentially like *T. fulvulus* described earlier, except that the eye of the living female typically has a single purple band in contrast to the usual three bands of *T. fulvulus* and the male of *T. pallidescens* has large and small facets of eyes more distinctly differentiated than *T. fulvulus*.

Comments: This species is abundant and widespread in Tennessee, but has been rare or absent from two surveys on the Cumberland Plateau (Mullens and Gerhardt 1980; Pechuman 1954). It can be a pest of cattle and horses from mid-June to early July (Figure 58) and has been collected from 25 May to 4 August. Tidwell and Tidwell (1973) reported collecting larvae from ruts of an old logging road in a mixed pine-hardwood forest and from well-drained soil at another location in a similar type of forest.

***Tabanus petiolatus* Hine.** Moderate (16 mm); dark brown with grayish white pattern; basal callus dark brown, higher than wide, rounded above, narrowly united with slender median callus; frons narrow, distinctly widened above; abdomen dark brown to blackish, darker posteriorly, with a distinct median row of grayish white triangles, that of tergite 2 almost always broadly reaching anterior margin; wing hyaline, fork and to a lesser extent the crossveins with brown spots, first posterior cell nearly always closed and petiolate; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: Specimens from western Tennessee separate easily from *T. melanocerus* but appear to integrade with *T. melanocerus* in the eastern portion of the state, where *T. petiolatus* is far less common. It can be a pest of cattle in western counties. Peak abundance appears to be in early to mid July, but specimens have been collected from 15 June to 7 September (Figure 59). Teskey (1969) reported taking larvae of this species from the banks of streams in leaf mold liberally mixed with sand or in moss; Tidwell (1973) reported finding larvae in small, sandy-bottomed streams found in pine or upland hardwood forests. Larvae of this species have been collected from the banks of small woodland streams in areas of mixed sandy and silty soil containing very little decaying vegetative matter.

***Tabanus proximus* Walker.** Large (26 mm); dark brown; basal callus reddish brown, distinctly higher than wide, narrowly united with elongate attenuate median callus; frons

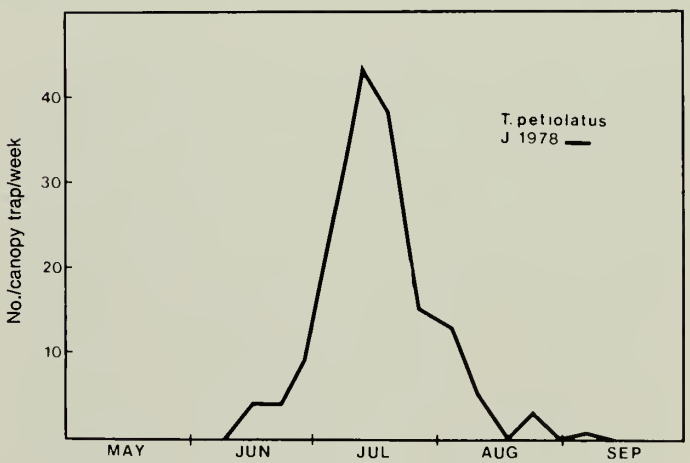


Figure 59. Seasonal abundance of *T. petiolatus* (Jackson, Madison County).

narrow, widened above; abdomen black, thinly grayish pollinose; wing pale brownish, fork and crossveins with spots, costal cell brownish; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: We have not found large populations of *T. proximus* in the state. This species appears to be more common in western Tennessee, but has been taken in eastern Tennessee. It will attack cattle and has a fairly late flight period, with specimens being taken from 5 July to 14 September. Tidwell (1973) reported taking larvae of this species from moist floodplain soils of large rivers, and it has been taken in similar areas in Tennessee.

***Tabanus pumilus* Macquart.** Small (9.5 mm); dark brown to grayish black; basal callus black, higher than wide, usually not connected with rather broad irregularly shaped median callus; frons narrow, distinctly widened above; second palpal segment with blunt apex, not greatly swollen basally; abdomen brownish black with grayish hind margins to tergites and small faint grayish median triangles and rounded grayish sublateral spots; wing hyaline; eyes bare. Male with large and small eye facets sharply differentiated; occipital tubercle conspicuous; eyes bare.

Comments: This tiny horse fly strongly resembles *T. sparus milleri,* but is less commonly collected in Tennessee. Eyes of live *T. pumilus* have two bands, while those of *T. sparus milleri* have one. This species will attack both people and cattle. Peak flight activity appears to be mid June, and collection records range from 22 May to 23 July. Teskey (1969) reported collecting larvae from almost totally organic substrates of bogs and swamps and once from silty soil of an open grassy spring-fed seepage area. Tidwell (1973) reported collecting a single larva from the margin of a small water-filled ditch. Numerous larvae have been collected in predominantly organic substrate in a spring-fed seepage area and a few from the margins of streams.

***Tabanus quinquevittatus* Wiedemann.** Moderate (12.5 mm); predominantly yellowish; basal callus black, about as high as wide, slightly rounded above, united with slender median callus at most by a narrow dark line; abdomen with a median parallel-sided yellowish stripe bordered by dark brown or black, sides yellowish; wing hyaline, costal cell yellow; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This medium-small "greenhead" is ubiquitous and extremely common in many areas of Tennessee. It will attack cattle, horses, and occasionally humans. It is particularly common near large areas of moist pasture, a favored breeding habitat for this species (Tashiro and Schwardt 1949).

A canopy trap operated in the same location at a pond edge on a Cumberland County farm for three consecutive years captured 865 specimens in 1977, 4022 in 1978, and only 366 in 1979. Almost nothing is known of tabanid population dynamics over a number of years, but it certainly appears that populations may fluctuate considerably from year to year.

Peak populations of *T. quinquevittatus* are usually found in late June and July, but high populations may persist through August. Extreme collection records range from 28 May to 28 September (Figure 60). Teskey (1969) reported collecting larvae from damp to wet grassy pasture sod bordering either temporary ponds or a spring-fed seepage swale.

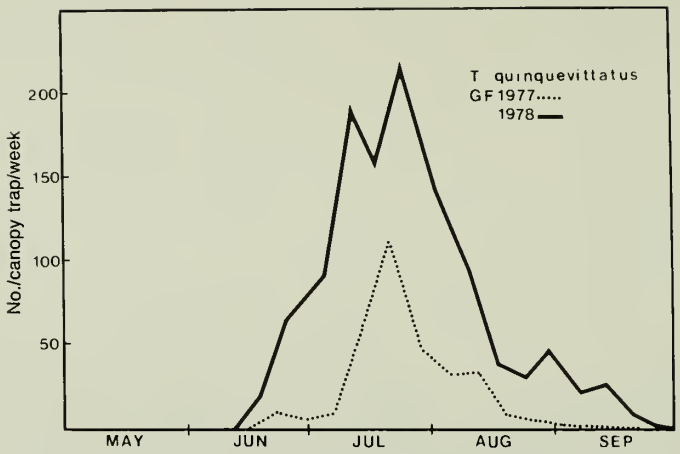


Figure 60. Seasonal abundance of *T. quinquevittatus* (Grasslands Farm, Plateau Experiment Station, Crossville).

Damp, semiarable soils were noted as habitats for larvae of this species by Logothetis and Schwardt (1948) and Tashiro and Schwardt (1949). Larvae have been collected from damp soil around the roots of grasses growing in a low area of a pasture.

***Tabanus reinwardtii* Wiedemann.** Moderate (17 mm); grayish black; basal callus reddish brown to black, nearly square, usually separated from short, slender median callus; frons broad, parallel sided or slightly narrowed above; abdomen black with pale hind margins and distinct grayish, narrow median triangles and larger sublateral spots, these not joined posteriorly; wing hyaline, fork and crossveins spotted with brown; eyes bare or with sparse short hairs. Male with large and small facets little differentiated; eyes hairy.

Comments: This interesting species, though fairly common in larval collections, is less commonly collected as an adult in the same areas (Pechuman 1973). Its habits are obscure, but several specimens have been captured from the ventral midline of cattle during the day. Collection dates range from 8 June to 4 August. Teskey (1969) reported collecting larvae in saturated or silty materials, often overlaying clay, on the banks of sluggish streams or small stagnant pools. Tidwell (1973) collected larvae from the margin of a stream, and Jones and Bradley (1923) stated that larvae were taken from the sandy margin of a sluggish brook. Larvae have been collected from the upper few centimeters of the forest floor in a mixed bottomland/hardwood forest area subject to frequent, short periods of inundation; the soil was silty to sandy and was overlain with leaf litter. Subsurface seepage and surface flow from numerous small springs were also characteristics of the area.

***Tabanus sackeni* Fairchild.** Moderate (13.5 mm); brownish with grayish pattern; basal callus brown to black, a little higher than wide, not united with irregularly shaped median callus; frons narrow, distinctly widened above; third antennal segment very slender, basal plate longer than combined length of annuli; abdomen brownish with a pale median line of grayish contiguous triangles and grayish sublateral spots; wing hyaline; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This tabanid is widespread in Tennessee, but it is not frequently collected in many areas, perhaps due to its crepuscular and nocturnal flight habits. Adults of both sexes have been collected in light traps. It has been taken attacking cattle during the day and one has been taken attacking man. Records range from 20 June to 28 September, but the main flight period for this species is mid July to late August. Goodwin (1976c) reported taking larvae from a depth of 10-18 cm in damp soil under a predominantly maple canopy on a well-drained hillside.

***Tabanus sagax* Osten Sacken.** Moderate (14 mm); orange brown with yellowish pattern; basal callus dark brown, about as high as wide, slightly constricted above, narrowly united with short, broad median callus; frons broad, parallel sided; third antennal segment relatively narrow, basal plate in length about equal to combined length of annuli; abdomen with a median line of contiguous yellowish triangles and indistinct sublateral spots; wing hyaline; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This species is not commonly collected in the state. It has been taken from 28 May to 25 July. The immature stages are not known.

***Tabanus similis* Macquart.** Moderate (13 mm); brownish to black; basal callus brown to black, nearly square, usually narrowly united to slender median callus; frons broad, widened above; scutellum reddish brown at tip; hind femora reddish; abdomen with pale median stripe and sublateral stripes, the latter usually with nearly parallel sides; wing hyaline; eyes bare. Male with large and small eye facets but these not sharply differentiated; eyes bare or with a few scattered hairs.

Comments: Females of *T. similis* can be difficult to separate from *T. subsimilis*, a species much more common in Tennessee. Collection records range from 30 May to 12 September but the late records may be part of a partial second brood. Teskey (1969) reported collecting larvae at the margins of willow-sedge marshes; a small, flooded woodland meadow; the shaded margin of a pond; and among cattails bordering a sphagnum bog. The margin of a slough is the larval habitat reported by Burger (1977).

***Tabanus sparus* Whitney.** Small (10 mm); grayish black; basal callus dark brown, quadrate, usually narrowly connected to slender elongate median callus; frons broad, slightly widened above; second palpal segment acute at tip, distinctly swollen basally; abdomen with a row of small grayish median triangles and oval sublateral spots; wing hyaline; eyes bare. Male with large and small eye facets sharply differentiated; occipital tubercle inconspicuous, usually laterally compressed; eyes bare.

Comments: Two varieties, *T. sparus sparus* and *T. sparus milleri,* are recognized. Philip (1947) reported *T. s. sparus* from Tennessee, but this was probably *T. sparus milleri*. The latter variety has a single eyeband in life, while *T. s. sparus* has none. We have never collected Tennessee specimens of this species lacking the eyeband. The tiny *T. s. milleri* is extremely common and widespread in the state, and readily attacks both man and cattle. It has been collected from 20 May to 7 September but the primary activity period is from early June to mid July (Figure 61). Teskey (1969) collected larvae (variety not indicated) in an abandoned cranberry bog and at the boggy margins of streams. Larvae of *T. s. milleri* have been collected from wet organic mud at the margins of streams and from predominantly organic substrate in a spring-fed seepage area.

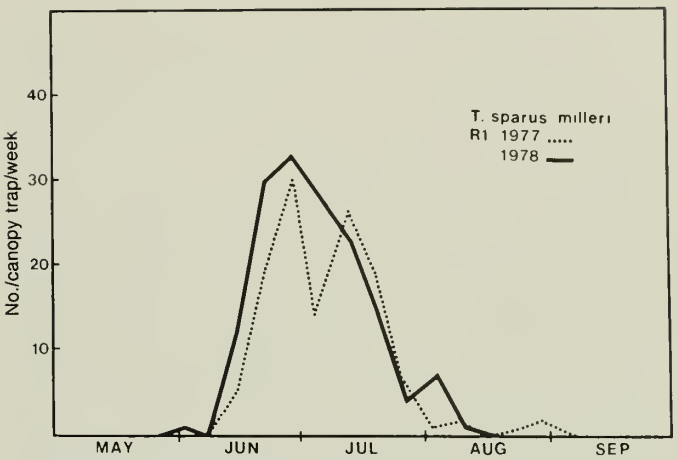


Figure 61. Seasonal abundance of *T. sparus milleri* (W. W. Stanley Cabin, Rafter, Monroe County).

***Tabanus stygius* Say.** Large (22 mm); thorax with dense covering of white hairs; abdomen black; basal callus reddish brown, higher than wide, rounded above, distinctly connected to slender median callus; frons broad, parallel sided; wing yellowish, fork and crossveins with brown spots, costal cell dark yellowish; eyes bare. Male with large and small eye facets sharply differentiated; hairs of thorax dark brown; eyes bare.

Comments: This is not a common species in the state, but a few specimens have been collected from 17 June to 6 July. Teskey (1969) found larvae in the saturated silty-clay bank of a stream overhung by shrubs but otherwise devoid of vegetation. Tidwell (1973) collected larvae at the margin of a ditch filled with water hyacinth in a coastal marsh area and at the margins of ponds in mixed bottomland/hardwood areas. Larvae have been found in saturated mud around the roots of aquatic vegetation growing in slow-moving streams.

***Tabanus sublongus* Stone.** Moderate (13 mm); dark orange brown with yellowish to orange pattern; basal callus dark brown to black, square or slightly higher than wide, separated from slender median callus; frons moderately broad, parallel sided; third antennal segment slender, basal plate a little longer than combined length of annuli; abdomen with a median row of pale yellowish contiguous median triangles and grayish yellow to orange sublateral spots; wing hyaline; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This is one of the *longus* group of species that can be difficult to separate, as discussed earlier. The primary flight period for *sublongus* seems to be in mid July, with records ranging from 29 June to 16 September. It will attack cattle and seems more numerous in the eastern mountains. The immature stages are not known.

***Tabanus subsimilis* Bellardi.** Moderate (13 mm); like *T. similis* described earlier, except for the following: hind femora dark brown to blackish; sublateral abdominal stripes usually offset between second and third tergites. Male with large eye facets rather sharply differentiated from small facets; area of large facets hairy.

Comments: *Tabanus subsimilis* is very widespread across the state and a common pest of cattle in some areas. It has a very long flight period, with collection dates ranging from 11 May to 10 October. While some areas show no marked peak of seasonal activity, at least as reflected by canopy traps, others seem to show two activity periods, one in June and a probable second brood in September (Figure 62). Goodwin (1973b) reported taking larvae from below the waterline near the margins of a small sink-hole pond, and a larva was also collected from the same floating fecal mats mentioned under *T. atratus*.

***Tabanus sulcifrons* Macquart.** Fairly large (21 mm); reddish brown with grayish to yellowish pattern; basal callus brown, higher than wide, rounded above, distinctly but narrowly connected with fairly broad elongate median callus; frons broad, slightly widened above; abdomen with a median row of relatively broad grayish to yellowish triangles and pale hind margins that broaden laterally; wing somewhat tinted, fork and crossveins with brown spots, costal cell orange; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This large, orange-tinted horse fly is found statewide and is a severe pest of cattle in many areas. The species is part of a complex that includes the Tennessee species *T. abdominalis, T. limbatinevris, T. sulcifrons,* and possibly *T. gladiator.* The species currently called *T. sulcifrons* tends to have two distinct peaks of activity—one in late June or July and one in late August or September (Figure 63). Additionally, the general morphological appearance of these two forms differs. The early group tends to be larger (22 mm), with a brownish thorax, yellowish abdominal triangles, and a lighter "burnt orange" abdomen; it has a yellowish cast to the wings. The late group is smaller (19.5 mm) and has a lighter, almost lavender-gray thorax, silvery yellow abdominal triangles, a darker abdomen, and often lacks the yellowish tint in the wings. Judging from the seasonal separation and morphological dissimilarities, probably two species are involved. Unfortunately, individual variability covers almost the whole range of intermediate characters. Burger (1980) has discussed the problematic *sulcifrons* group, as well as the two seasonal forms, but was not able to make a specific distinction between them. Collection records range from 14 June to 17 October.

Immatures may be found in aquatic situations, but tend to be terrestrial. Several adult females of this species have been taken from pitfall traps containing an ethylene glycol-water mixture and set in a tobacco field. The immature stages of this species are known, but they have not been described recently. The larvae collected and described by Teskey (1969) as *T. sulcifrons* have proven to be *T limbatinevris,* a species not recognized at the time of the larval description. Larvae from New York reared from eggs by Tashiro (1950) do, however, represent *T. sulcifrons.* The former author provided a brief description of the larvae, and Teskey (1969) commented on differences between his *T. sulcifrons* (= *T. limbatineviris*) and those described by Tashiro. No field collections of larvae confirmed to be *T. sulcifrons* are known.

***Tabanus superjumentarius* Whitney.** Moderate (16 mm); black and grayish white; basal callus yellowish to orange brown, higher than wide, narrowly united to slender, very elongate median callus; frons narrow, distinctly widened above; abdomen black with small median white triangles on tergites 2-5, that of 2 very small; fore tibia uniformly dark; wing yellowish, dark anteriorly; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This species is fairly common in some areas of the eastern mountains, but is seldom found elsewhere in the state. It resembles *T. trimaculatus,* but the abdominal triangles are considerably smaller in *T. superjumentarius,* which also has uniformly dark fore tibia (white basally in *T. trimaculatus).* It has been collected from 25 May to 27 July and seems most prevalent in mid to late June. It will attack cattle. Teskey (1969) collected larvae from wet silty soil over-

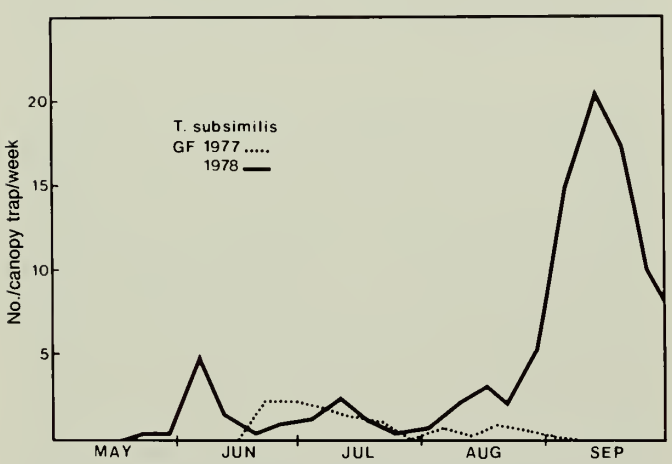


Figure 62. Seasonal abundance of *T. subsimilis* (Grasslands Farm, Plateau Experiment Station, Crossville).

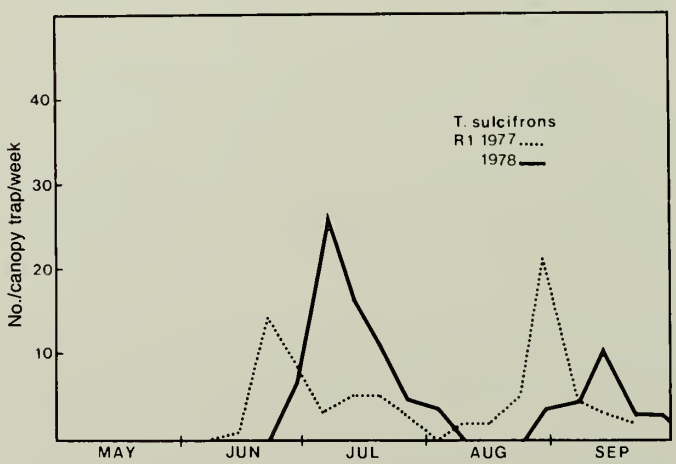


Figure 63. Seasonal abundance of *T. sulcifrons* (W.W. Stanley Cabin, Rafter, Monre County).

grown with grass on the banks of a creek. Larvae have been collected from silty mud of a small woodland brook and in wet mud at the margin of a pond.

***Tabanus trimaculatus* Palisot de Beauvois.** Moderate (16 mm); black and grayish white; basal callus orange brown to black, higher than wide, rounded above, distinctly connected to relatively short slender median callus; frons broad, slightly widened above; abdomen with median white triangles on tergites 3-5, tergite 2 occasionally with a pair of small sublateral white spots; fore tibia whitish on basal half; wing nearly hyaline, costal cell dark yellow, fork and crossveins with brown spots; eyes bare. Male with large and small eye facets sharply differentiated; eyes bare.

Comments: This striking black and white species, pictured on the cover of this report, is fairly common and quite widespread in Tennessee. Populations tend to be highest in late June, and collection records range from 15 May to 10 August (Figure 64). It will attack cattle. Goodwin (1973b) reported taking larvae from wet mud at the margins of streams, ponds, lakes and sloughs; once from a submerged, saturated, decaying log; and from organic mud in spring-fed seepage areas. Tidwell (1973) took larvae from the mud of streams, ditches, and temporary ponds in forested areas.

***Tabanus turbidus* Wiedemann.** Large (21 mm); brownish; basal callus reddish brown, about twice as high as wide, distinctly but narrowly connected to very elongate median callus; frons narrow, widened above; abdomen orange brown usually with a median row of faint grayish triangles; wing tinted yellowish, costal cell darker, fork and crossveins faintly brown; eyes bare. Male with upper eye facets enlarged but not sharply differentiated from small facets; eyes bare.

Comments: In spite of its crepuscular and nocturnal habits, *T. turbidus* has been collected in many areas of the state. Both sexes often are taken in light traps. In eastern Tennessee, large numbers have been observed attacking cattle at dusk, and they may also attack man. It has been collected from 31 May to 27 July, but most adult activity is in early July. The immature stages are not known.

***Tabanus venustus* Osten Sacken.** Moderate (17 mm); dark brown to black with whitish pattern; basal callus brown to black, quadrate, usually separated from small median callus, which is surrounded by a dark-brown to black pollinose region; frons broad, slightly widened above; abdomen with a median row of white triangles and faint pale sublateral spots on some tergites; wing with large brown maculations; eyes bare. Male with large and small eye facets hardly differentiated; eyes bare.

Comments: This beautiful tabanid is not common in Tennessee, but it has been collected in central and western counties from 1 June to 13 July. Goodwin (1976c) reported taking larvae from silty mud on the steep bank of a stream and Thompson (1978b) collected larvae at the margin of a small pond.

***Tabanus wiedemanni* Osten Sacken.** Fairly large (20 mm); dark brown to black, without pattern; basal callus a little higher than wide, protuberant, broadly joined to large

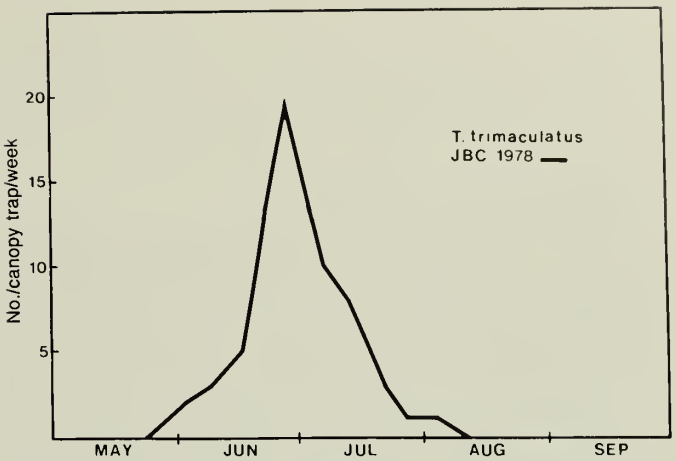


Figure 64. Seasonal abundance of *T. trimaculatus* (Johnson Bible College, Knox County).

dorsally tapered median callus, both dark brown and shiny; subcallus protuberant and at least partly denuded and shiny dark brown; frons moderately wide, about 3.5 times as high as wide, with nearly parallel sides; legs black; wing dark brown, slightly paler posteriorly, without distinct spots at fork or on crossveins. Male with areas of large and small facets distinctly differentiated; otherwise similar to female.

Comments: This species has not been collected in Tennessee, but it has been reported from Habersham County in northern Georgia (Beshear and Howell 1985). Jones and Anthony (1964) reported collecting larvae of this species in and among the root mats of a variety of aquatic plants growing near the edge of shallow water zones. Teskey and Burger (1976) described the immature stages based on specimens collected by Dr. L. L. Pechuman from sod projecting from a small pond.

***Tabanus wilsoni* Pechuman.** Moderate (13.5 mm); dark brown with yellowish brown pattern; basal callus dark brown, nearly twice as high as wide, separated from narrow median callus; frons narrow, slightly widened above; basal plate of third antennal segment orange, annuli black; thorax dark brown, without obvious pattern; abdomen dark brown with a median row of contiguous yellowish triangles and yellowish sublateral spots; wing hyaline, tinted yellowish including costal cell; eyes bare. Male with large and small facets of eyes little differentiated; eyes bare.

Comments: Records for this species are mostly restricted to the western portion of the state. It can be a fairly common species and collection records range from 3 June to 15 August. Tidwell and Tidwell (1973) found larvae in relatively dry, friable soil at the base of a large overcup oak tree in a bottomland/hardwood forest area.

***Tabanus zythicolor* Philip.** Moderate (12.5 mm); orange brown; basal callus yellowish to brown, higher than wide, constricted above, separated from oval median callus; frons relatively broad, parallel sided; abdomen with a median row of contiguous yellowish brown triangles and rounded sublateral spots; wing hyaline to faintly tinted, costal cell yellowish brown; eyes bare. Male with large and small eye facets not sharply differentiated; eyes bare.

Comments: Though not yet known from Tennessee, *T. zythicolor* is found in western North Carolina. Goodwin (1976c) reported collecting a pupa in moist sod about 4 m from the water line of a pasture depression; the area from which the pupa was taken is periodically flooded.

Genus ATYLOTUS Osten Sacken

Adults of this genus are small (9 mm) to moderate (12 mm) in size and can be separated relatively easily from other Nearctic Tabaninae by the characters used in the generic key. Separation of the adults into species, however, has been difficult because of variability within each species. Concerning the immatures, no characters have been found that allow separations of *Atylotus* from *Tabanus,* but they can be identified using available keys (e.g., Teskey 1969). Teskey (1983) revised the eastern North American *Atylotus* fauna, and provides keys for larvae and for adult males and females.

Philip (1965) listed seven Nearctic species, but Teskey (1969) described larvae of two species identified as *Atylotus* species A and *Atylotus* species B, noting inconsistencies in the apparent relationships indicated by adults and by larvae. The genus is primarily northern in distribution in the Nearctic Region, and Tennessee lies at or near the southern limit of the genus in the eastern Nearctic.

Tennessee collections of *Atylotus* total three adult specimens, two field-collected females and one male reared from a field-collected larva. Two, including the reared specimen, are *A. ohioensis,* and the remaining specimen is *A. duplex.* A third species, *A. bicolor,* may be present since it has been collected in Georgia. The previously reported Tennessee records of *A. thoracicus* (Hine) were due to misidentifications mentioned under *A. duplex* and *A. ohioensis.* A key and brief diagnostic descriptions of the three species are provided. Due to the paucity of Tennessee specimens and our limited experience with Nearctic *Atylotus,* both the key and the descriptions are modified from Pechuman (1981) and Teskey (1983).

KEYS TO ATYLOTUS *SPECIES*

Figures 9a, b, e, and f (p. 9) show several views useful when identifying female and male *Atylotus.*

Females

1. Pleural hairs bright yellow; basal plate about as broad as long ---------- *bicolor*
   Pleural hairs white; basal plate usually longer than broad ---------- 2
2. Pale hairs on scutum and abdomen white and concolorous with thoracic pleural hairs; postocular fringe of hairs white ---------- *ohioensis*
   Pale hairs of scutum and/or abdomen, at least faintly yellow and contrasting with white thoracic pleural hairs; postocular fringe usually predominantly black ---------- *duplex*

Males

1. Thoracic pleural hairs at least partially yellow; almost all body hairs yellow ---------- *bicolor*
   Thoracic pleural hairs completely white ---------- 2
2. All pale hairs on body white and concolorous with thoracic pleural hairs ---------- *ohioensis*
   Pale hairs on scutum and abdomen yellowish and contrasting with white thoracic pleural hairs ---------- *duplex*

***Atylotus bicolor* (Wiedemann).** Small to moderate (8-11 mm); yellow or light orange; abdomen with a median, indefinitely outlined dark area; wing predominantly hyaline, costal cell hyaline to pale yellow; legs mostly yellow. Male, apart from usual sexual differences, generally like female but with paler hairs and areas more obvious.

Comments: This species has not yet been collected in the state, but it has been collected in Georgia. Teskey (1969) reported collecting larvae in sphagnum bogs, gravelly soil covered by leaf debris on the bank of a pond, grass sod bordering temporary pasture ponds, boggy margins of ponds, wooded and open swamps, and silty vegetation-free soils bordering streams and rivers.

***Atylotus duplex* (Walker).** Small to moderate (9-12 mm); predominantly dark brown to black; abdomen mostly dark brown, paler laterally; wing mostly hyaline, but costal cell usually tinted pale yellow; legs mostly orange. Male, apart from usual sexual differences, extensively paler than female due to longer and paler body hairs and yellow ground color of lateral one-half to two-thirds of the anterior abdominal tergites; abdominal tergites predominantly yellow haired.

Comments: A single female was collected in a Malaise trap on 12 June in Cumberland County and was reported by Mullens and Gerhardt (1980) as *A. thoracicus.* Further examination of the specimen by Dr. L.L. Pechuman has indicated that it is actually closer to *A. pemeticus,* which is now placed as a synonym of *A. duplex.* The known distribution of *A. duplex,* excluding the Tennessee record, is more northern except for a record from western North Carolina. Teskey (1969) reported collecting larvae of *A. pemeticus* in wet moss of woodland swamps and spring-fed drainage beds.

***Atylotus ohioensis* (Hine).** Small (8-10 mm); thorax dark, with whitish pruinosity; abdomen blackish; wing hyaline; legs mostly yellow. Male, apart from usual sexual differences, generally paler than female, especially on abdomen where sides of tergites 1-3 are decidedly yellow and hairs of all tergites are long and predominantly white.

Comments: A single female of this species was collected 22 June in a canopy trap in Monroe County and a male was reared from a larva collected in Knox County. This male was previously reported as *A. thoracicus* by Goodwin (1966). Teskey (1969) reported collecting larvae in moss that grew on a saturated loamy soil in a small spring-fed seepage bed and in moss on a partially wooded hillside, again in an area kept damp by seepage from a spring. The larva taken in Knox County also was found in a seepage area on the soil surface beneath a section of a felled oak tree. Several larvae of *Leucotabanus annulatus* were found with it.

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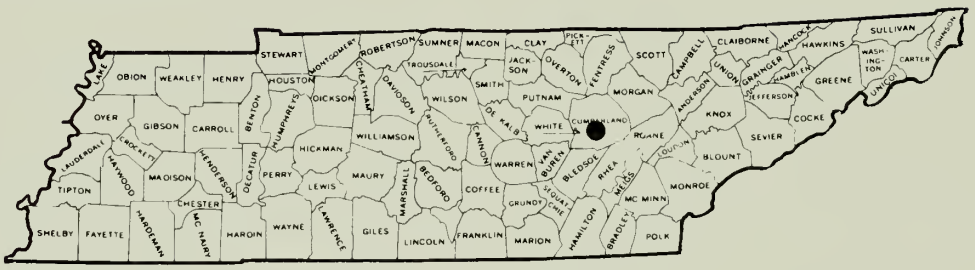
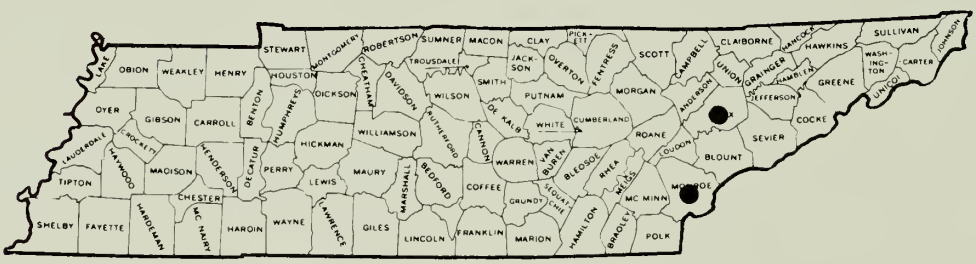
APPENDIX

Maps of Distribution of Tennessee Tabanidae

Genus ATYLOTUS Osten Sacken

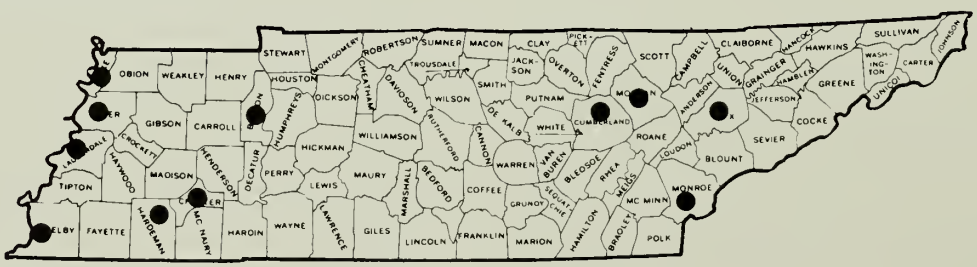


Atylotus duplex



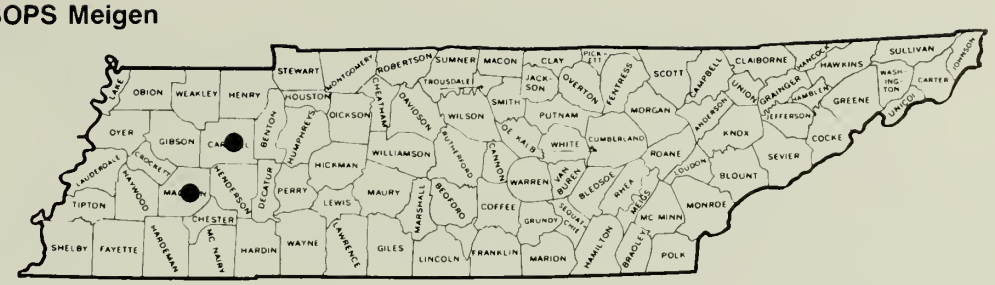
Atylotus ohioensis

Genus CHLOROTABANUS Lutz

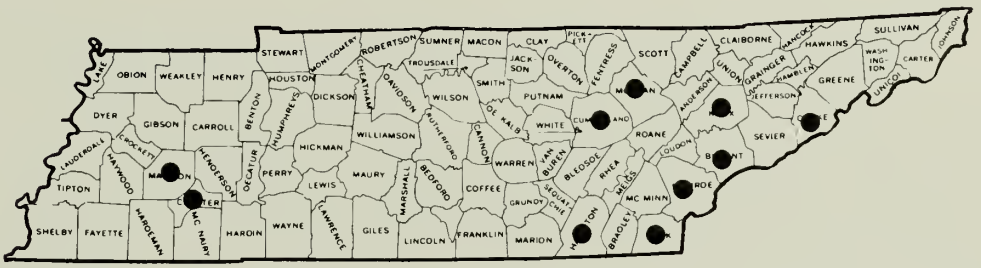


Chlorotabanus crepuscularis

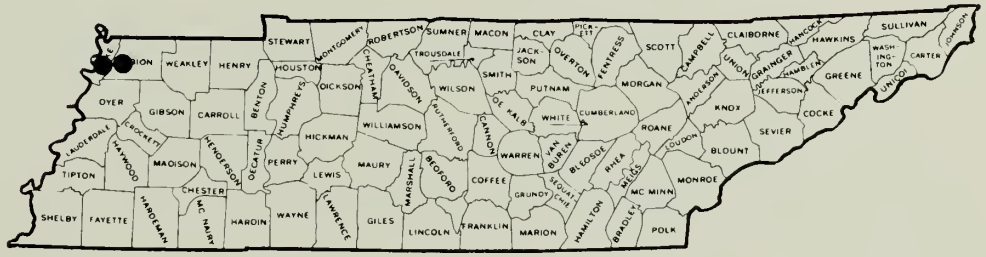
Genus CHRYSOPS Meigen



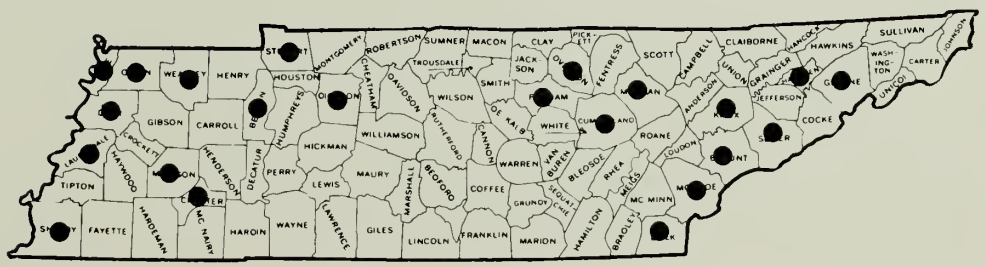
Chrysops beameri



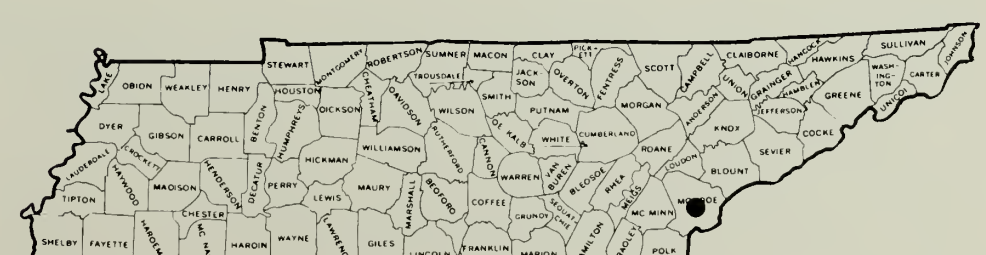
Chrysops brimleyi



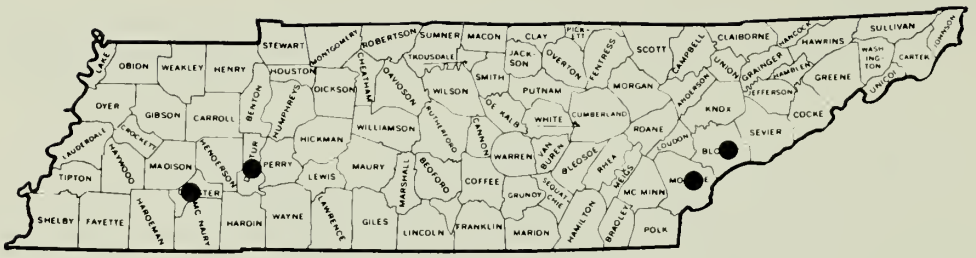
Chrysops brunneus



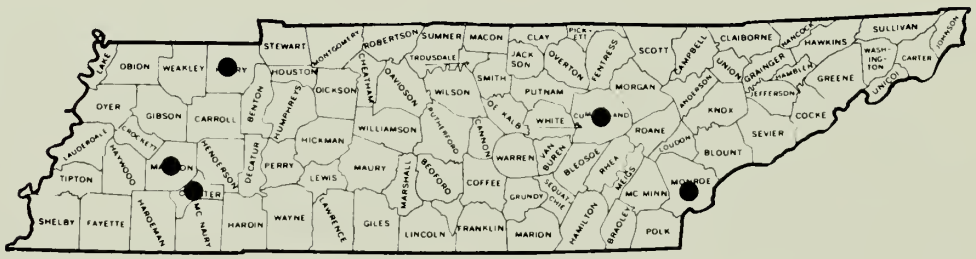
Chrysops callidus



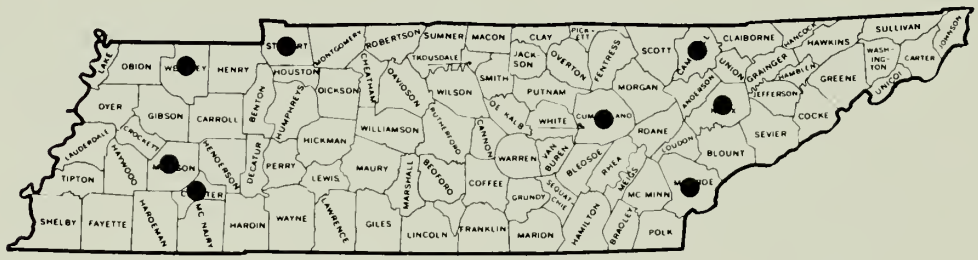
Chrysops calvus



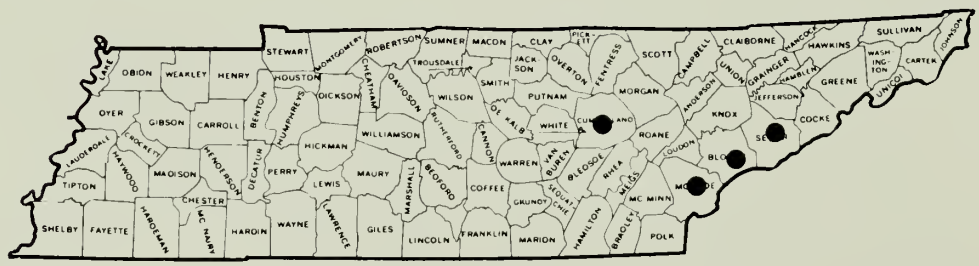
Chrysops carbonarius



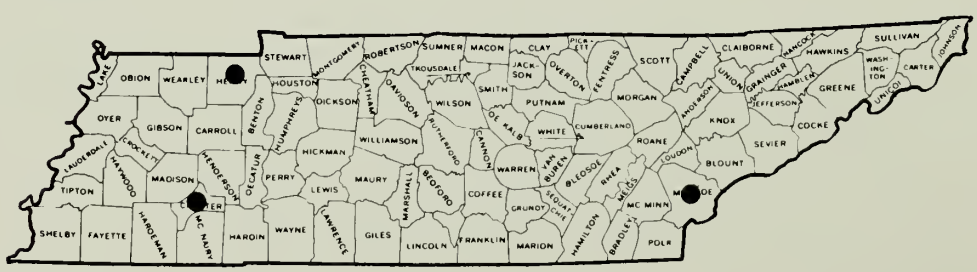
Chrysops celatus



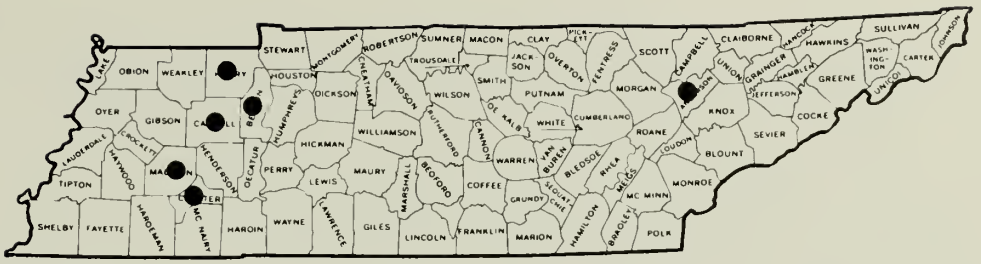
Chrysops cincticornis



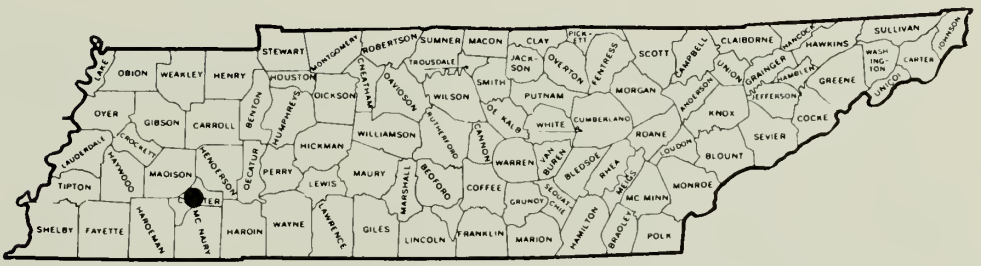
Chrysops cuclux



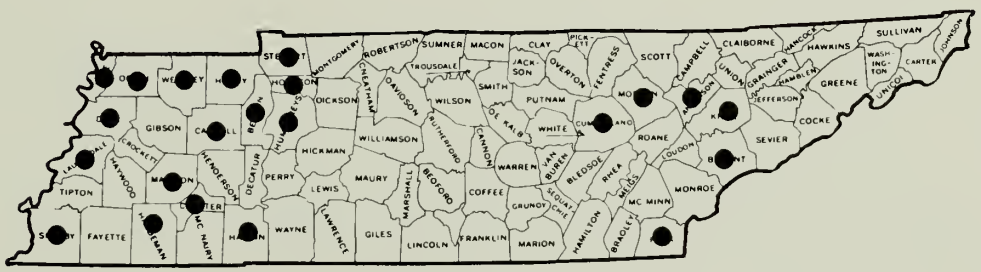
Chrysops cursim



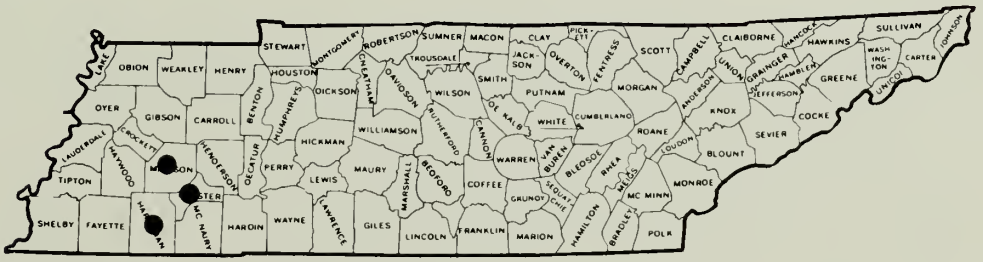
Chrysops dacne



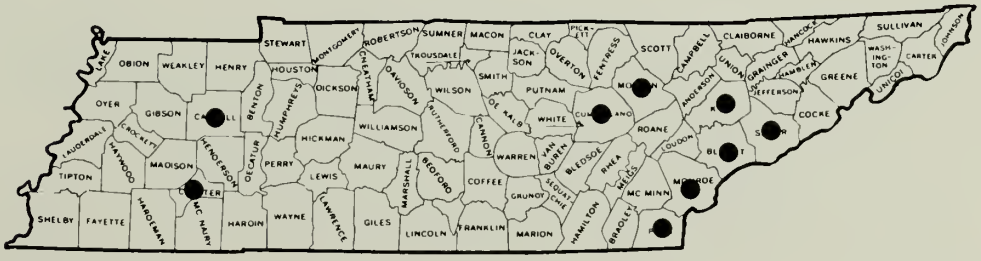
Chrysops dimmocki



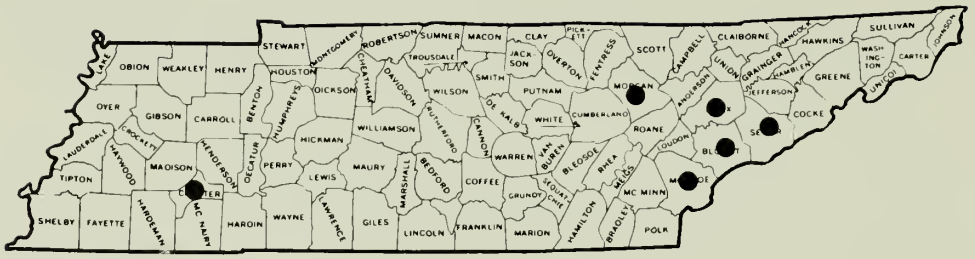
Chrysops flavidus



Chrysops fulvistigmus



Chrysops geminatus



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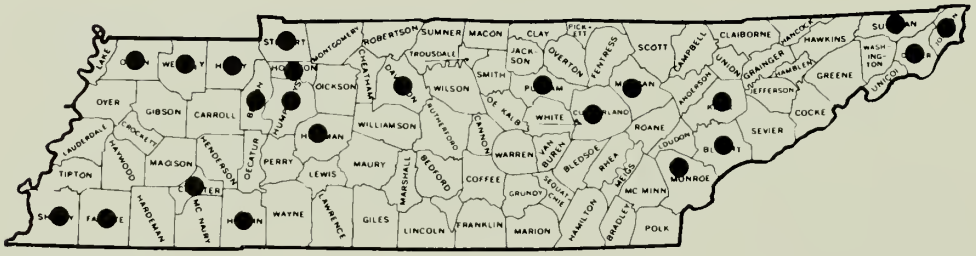
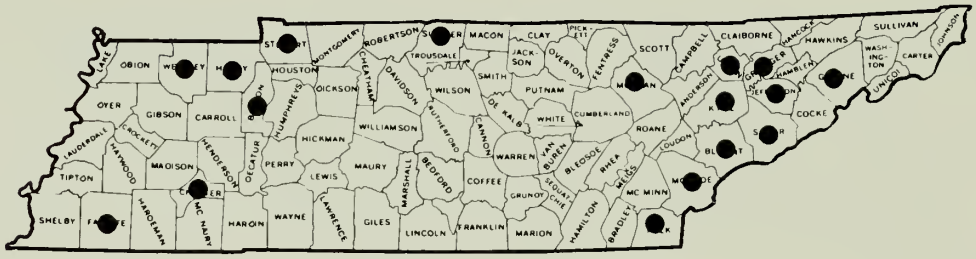
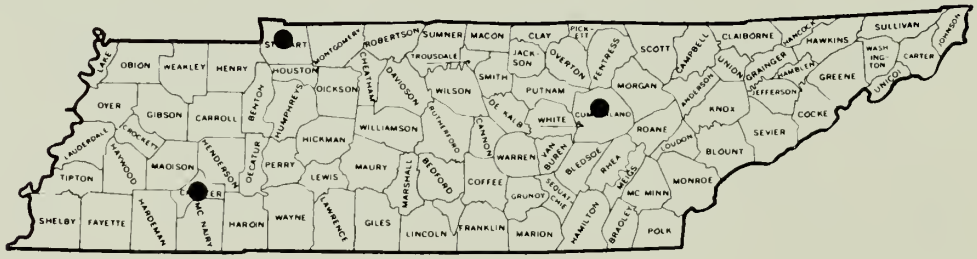


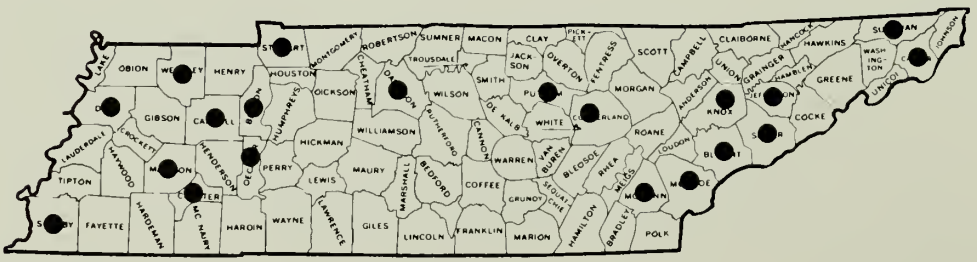
Chrysops macquarti



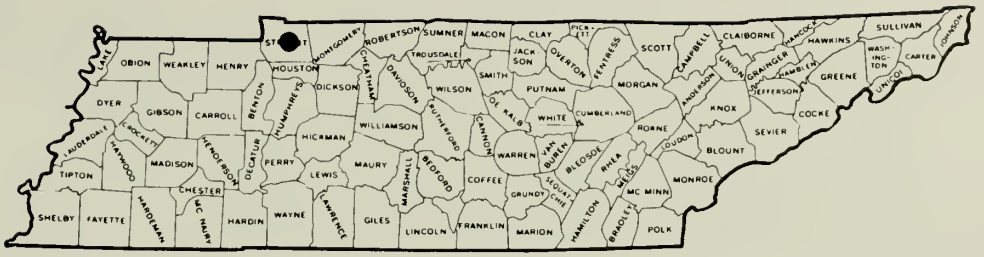
Chrysops moechus



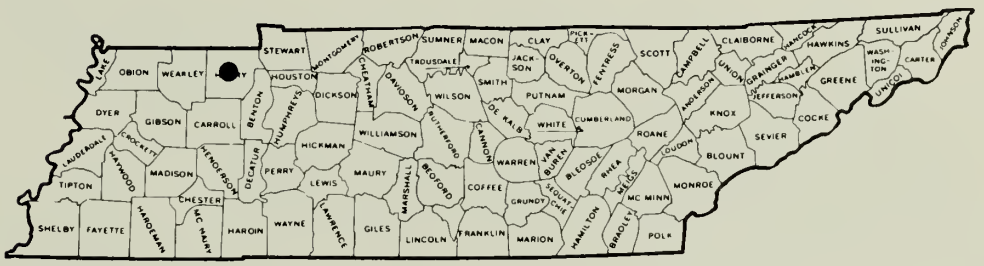
Chrysops montanus



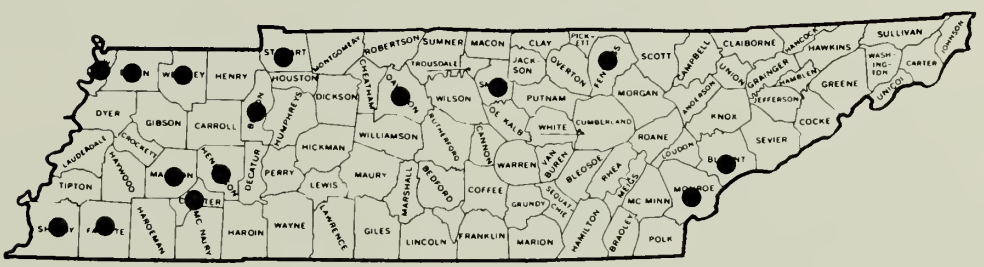
Chrysops niger



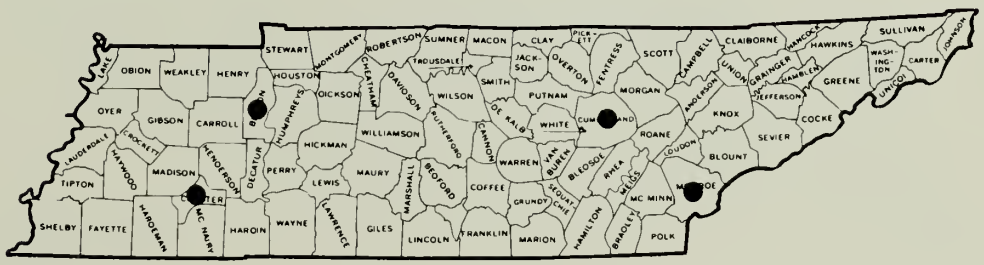
Chrysops nigribimbo



Chrysops parvulus



Chrysops pikei



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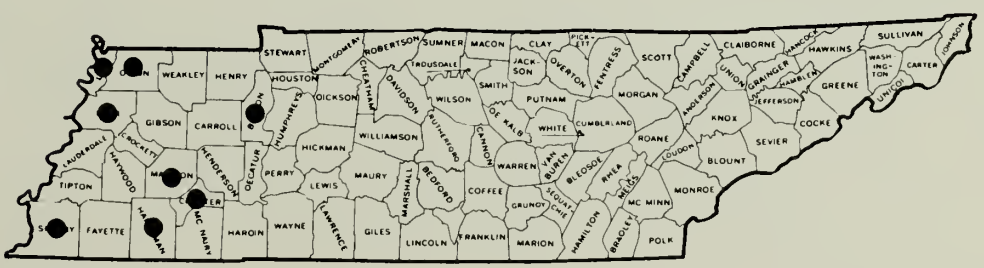
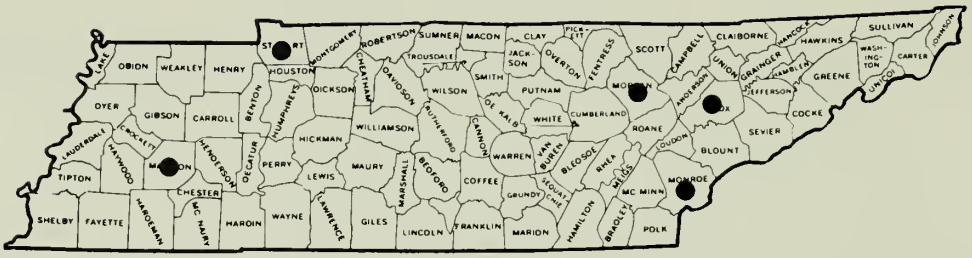
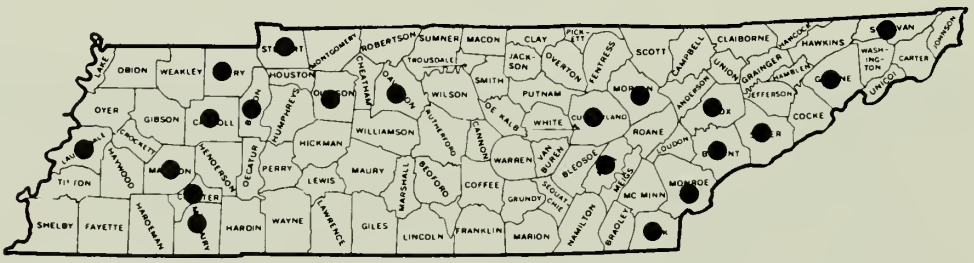


Chrysops reicherti



Chrysops separatus



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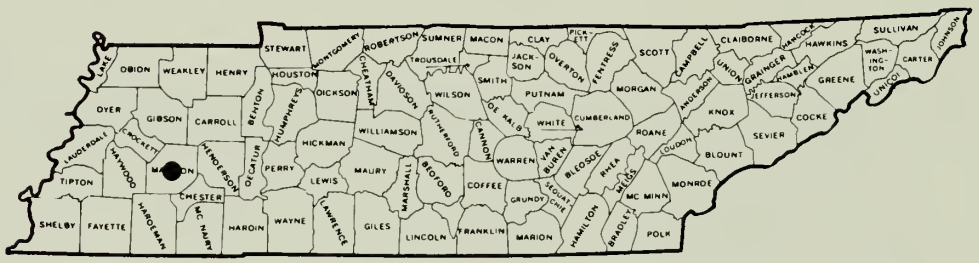
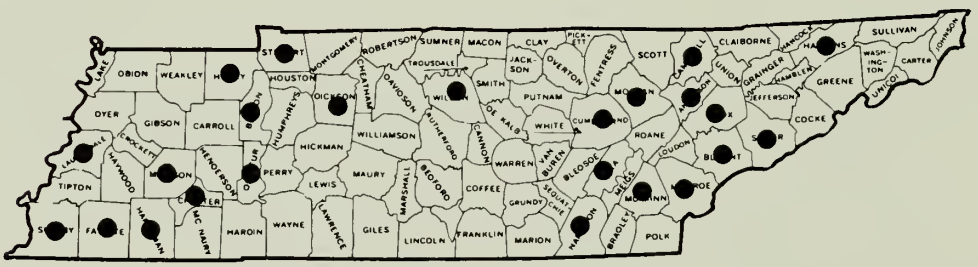
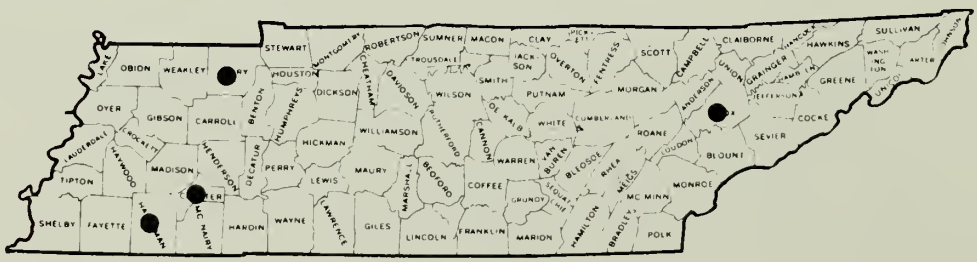


Chrysops upsilon



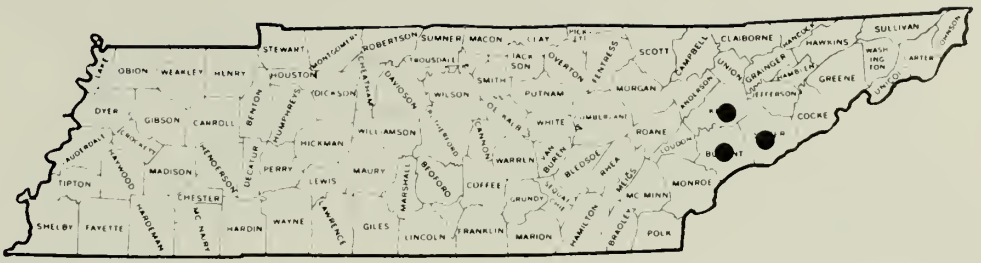
Chrysops vittatus

Genus DIACHLORUS Osten Sacken



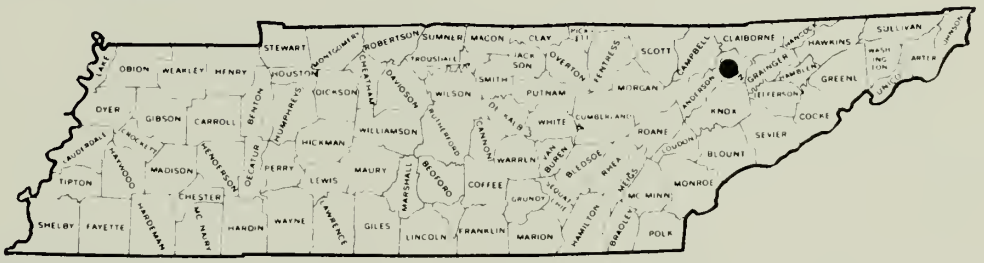
Diachlorus ferrugatus

Genus GONIOPS Aldrich



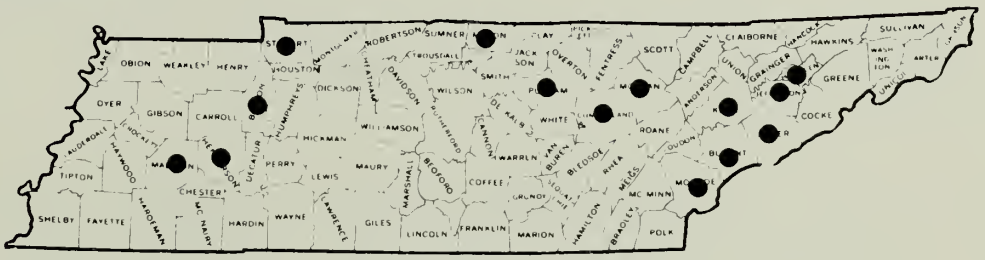
Goniops chrysocomus

Genus HAEMATOPOTA Meigen



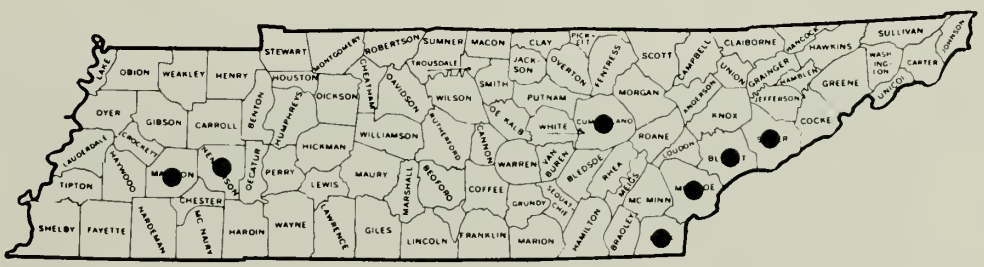
Haematopota rara

Genus HAMATABANUS Philip

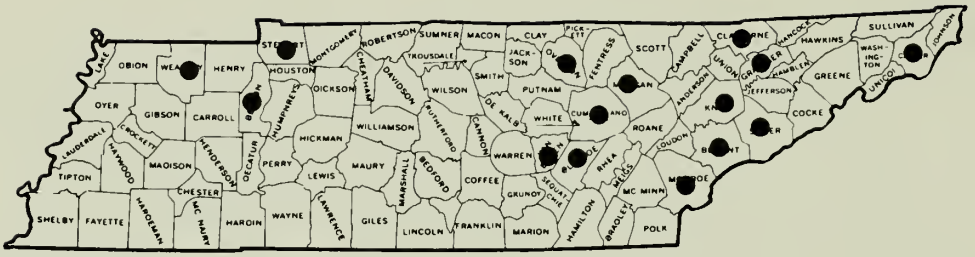


Hamatabanus carolinensis

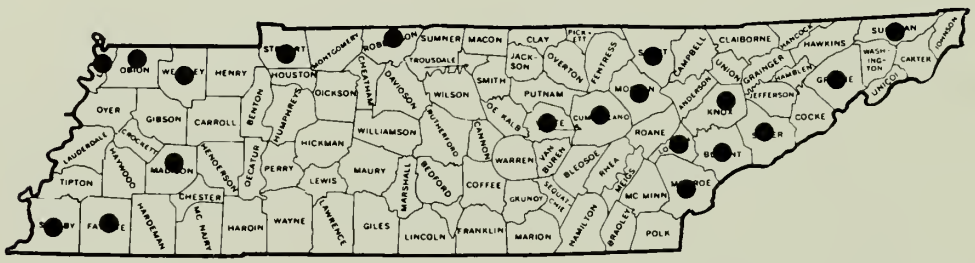
Genus HYBOMITRA Enderlein



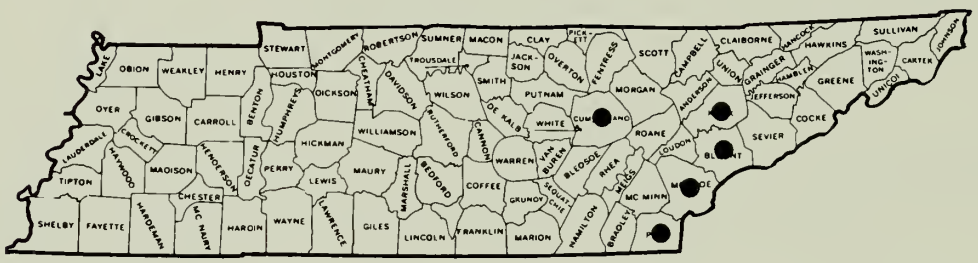
Hybomitra cincta



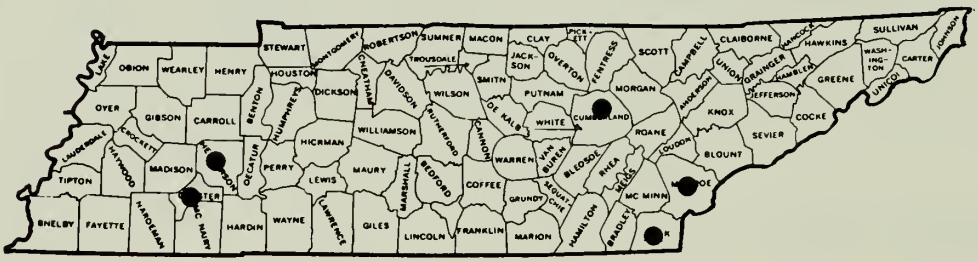
Hybomitra difficilis



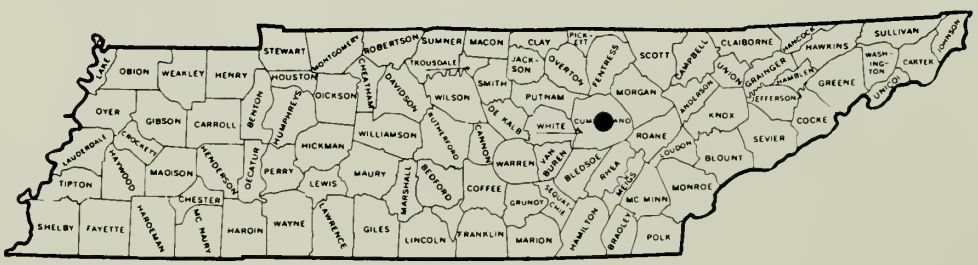
Hybomitra lasiophthalma



Hybomitra sodalis

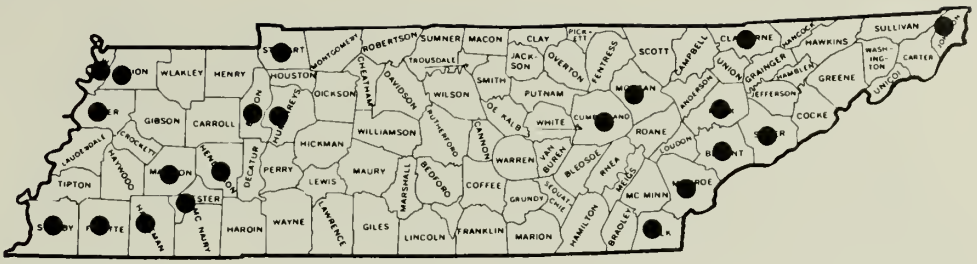


Hybomitra trispila



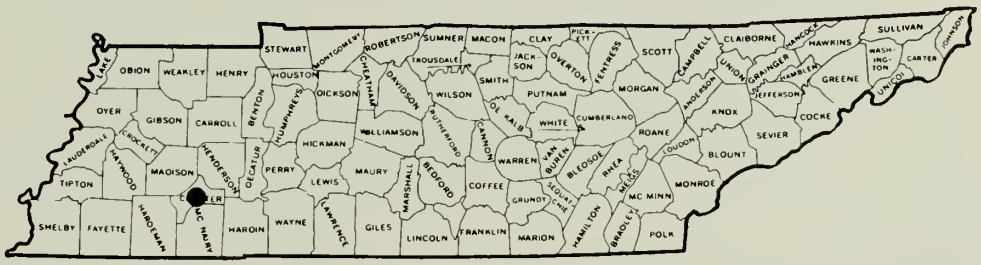
Hybomitra typhus

Genus LEUCOTABANUS Lutz



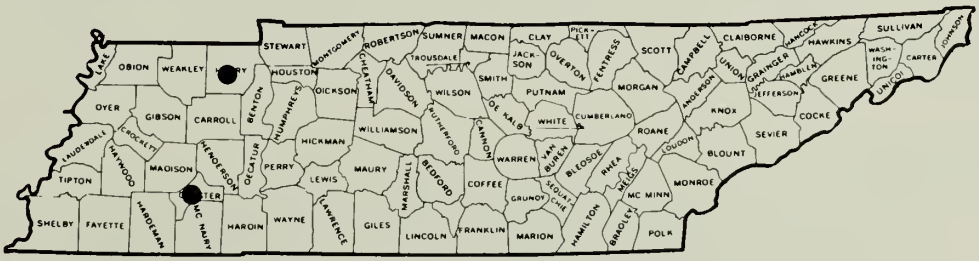
Leucotabanus annulatus

Genus MERYCOMYIA Hine



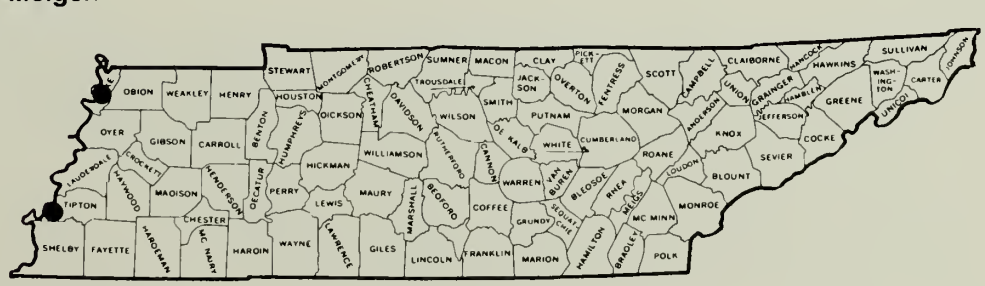
Merycomyia whitneyi

Genus NEOCHRYSOPS Walton



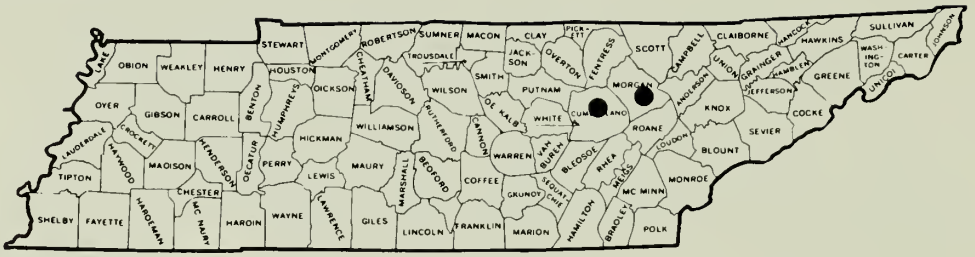
Neochrysops globosus

Genus SILVIUS Meigen

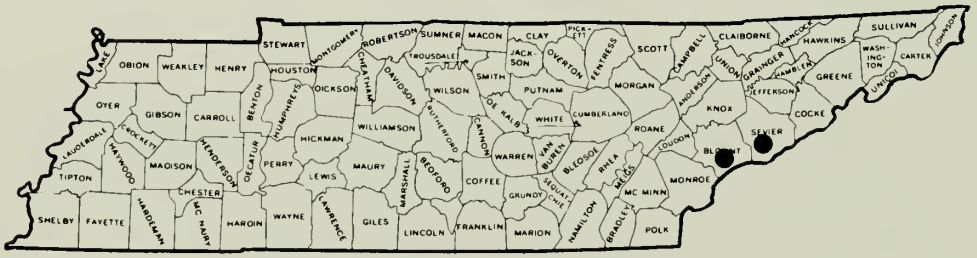


Silvius quadrivittatus

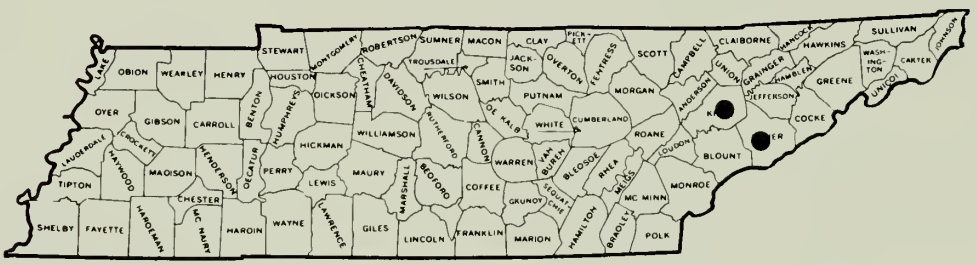
Genus STONEMYIA Brennan



Stonemyia isabellina

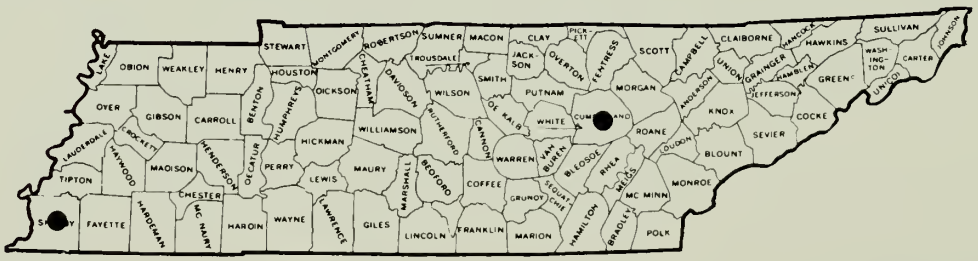


Stonemyia rasa

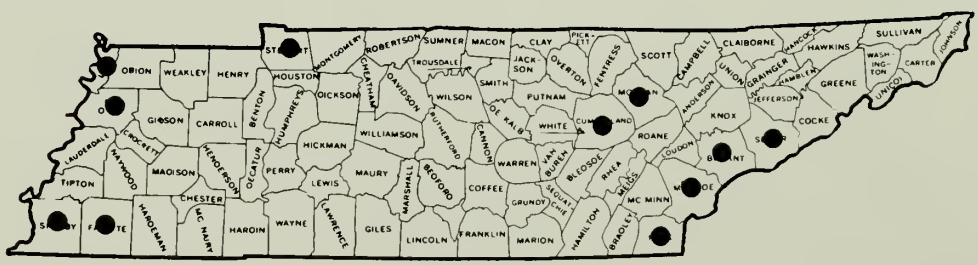


Stonemyia tranquilla

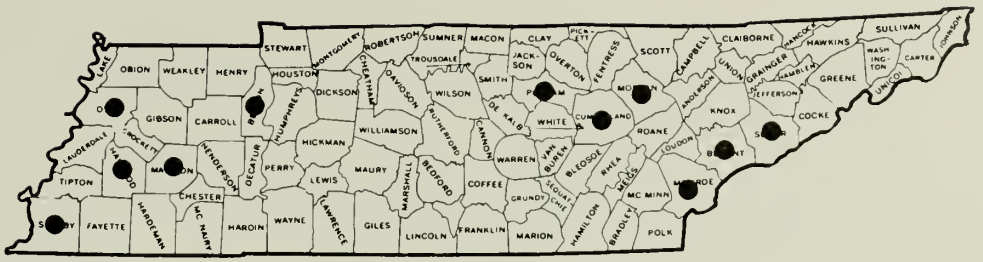
Genus TABANUS Linnaeus



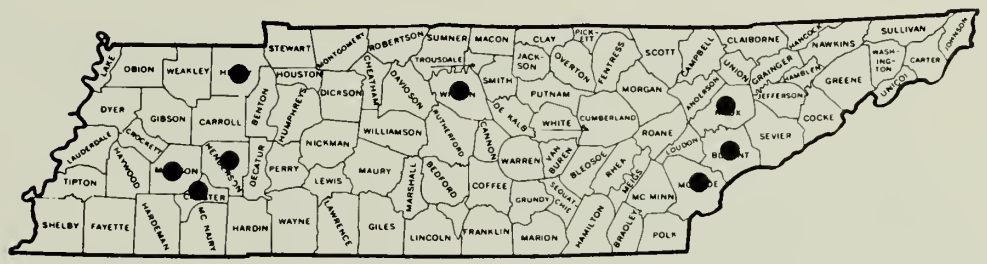
Tabanus aar



Tabanus abdominalis



Tabanus americanus



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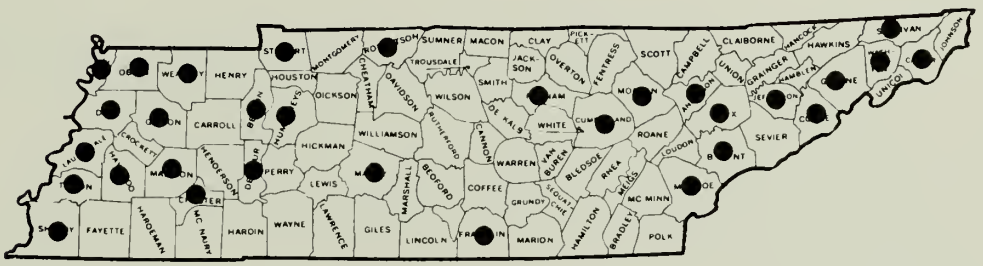

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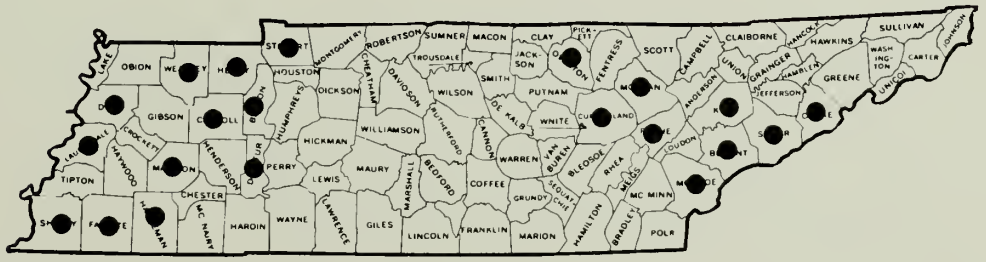

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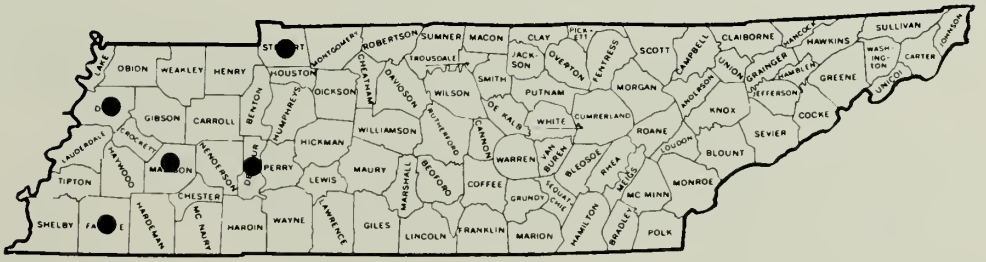

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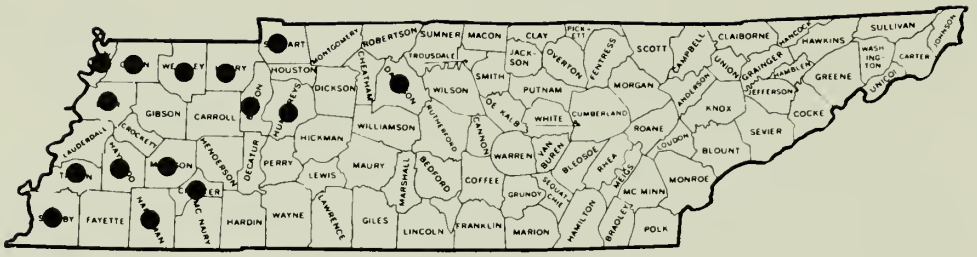

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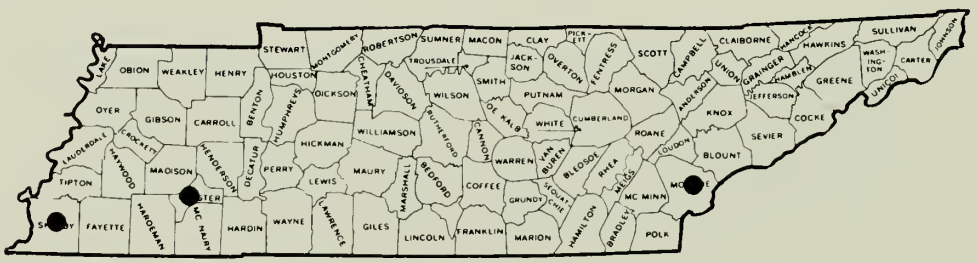

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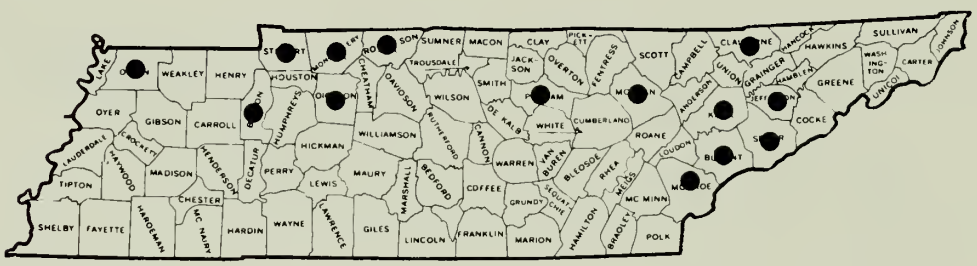

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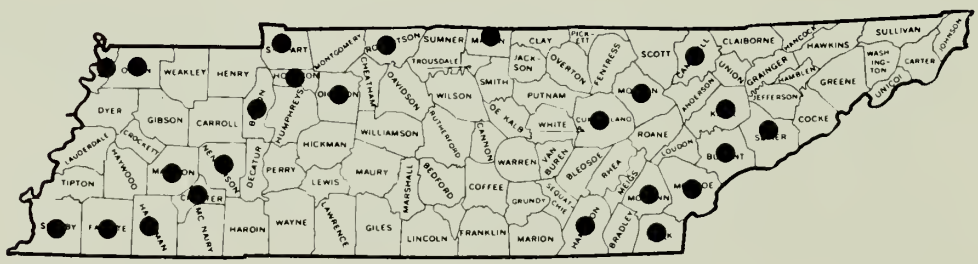

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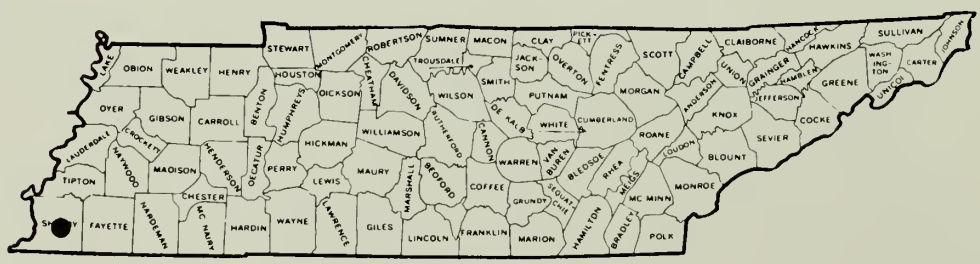

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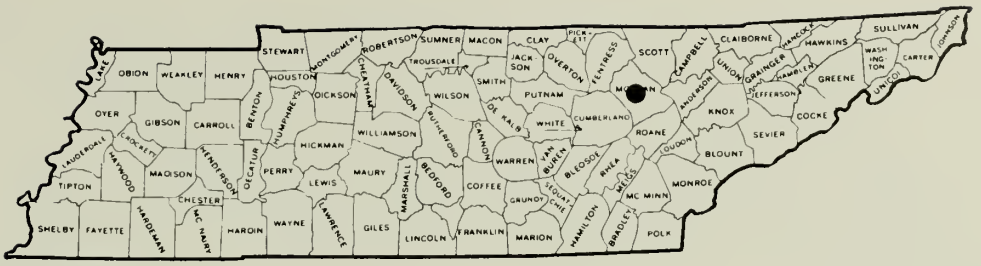

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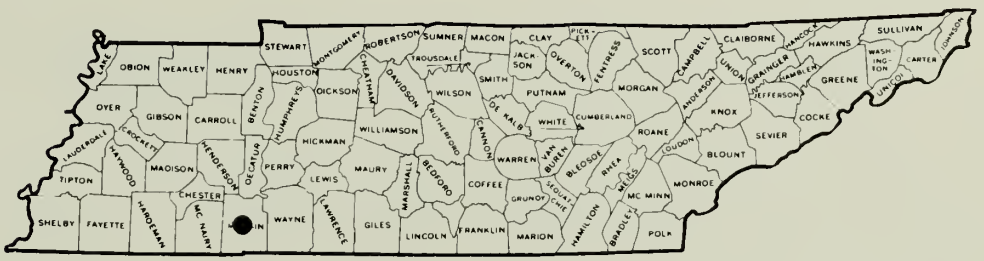

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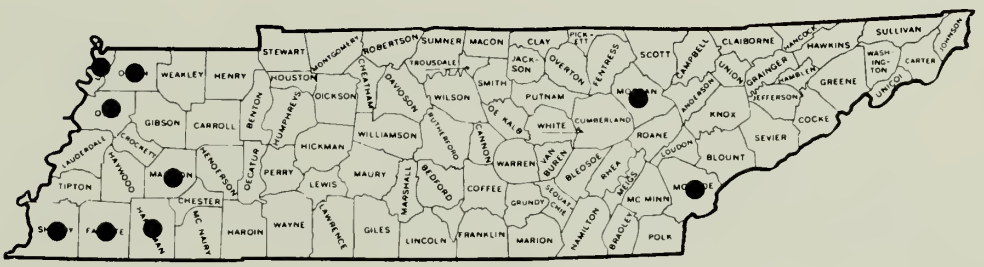

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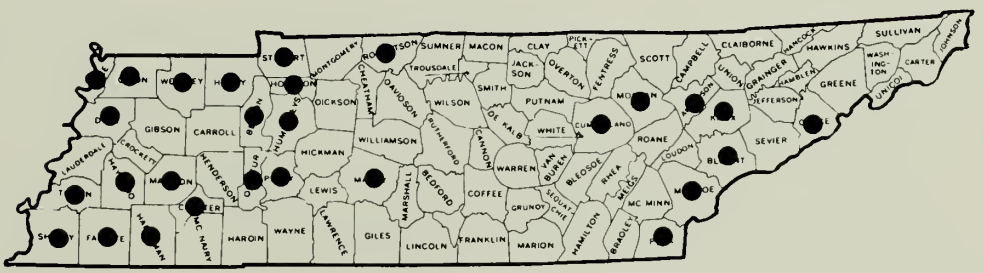

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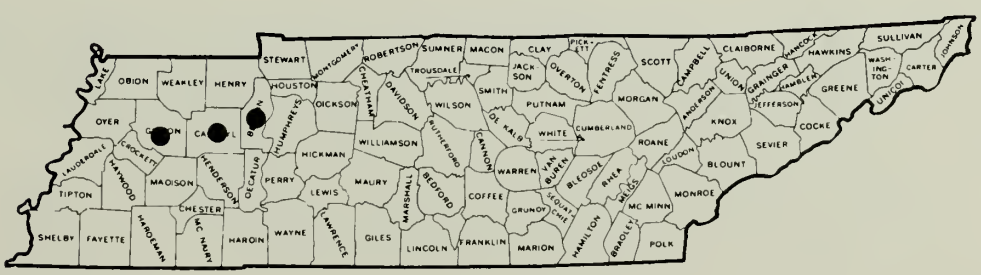

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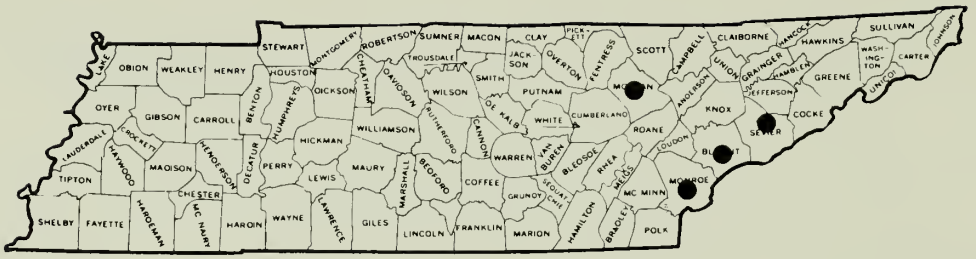

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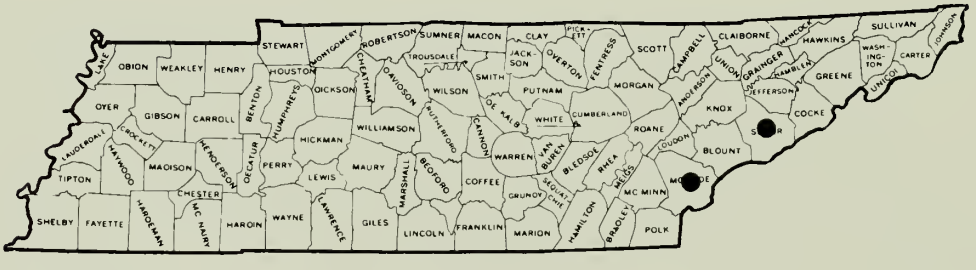

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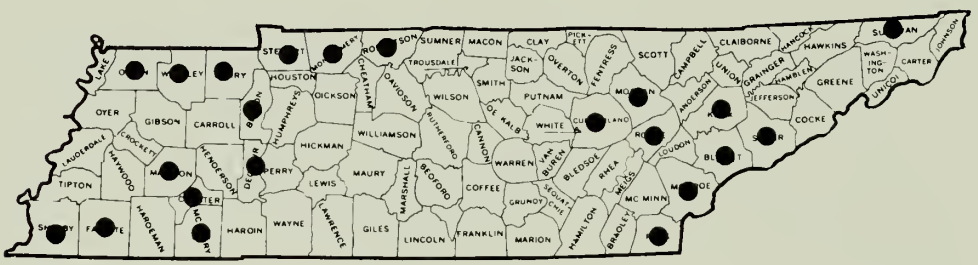

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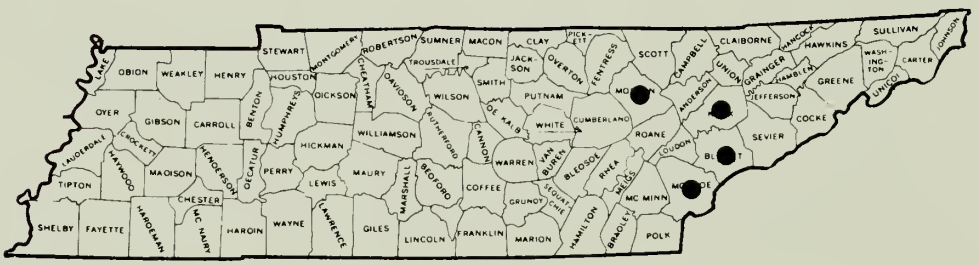

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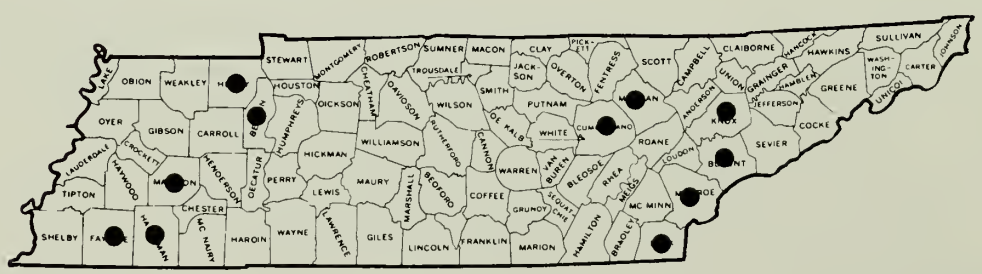

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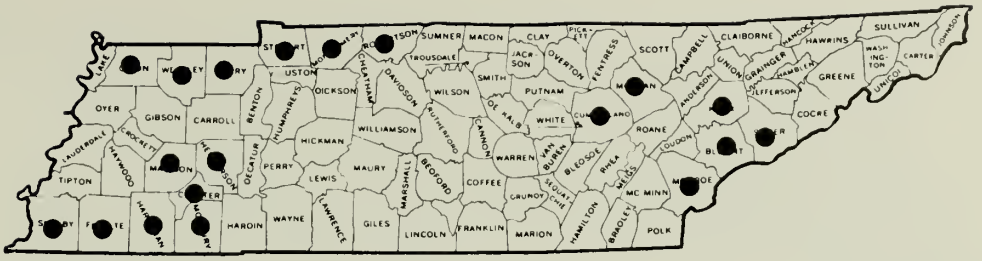

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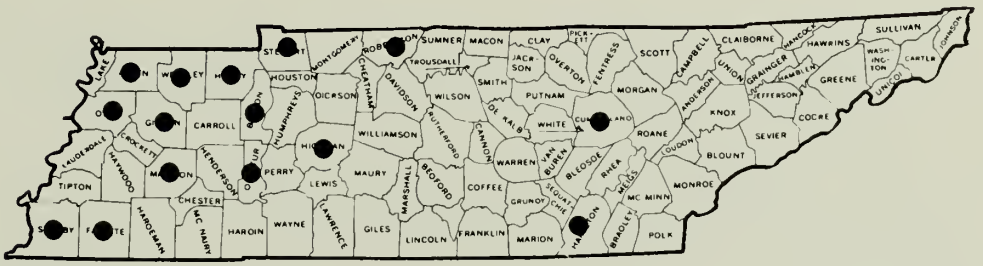

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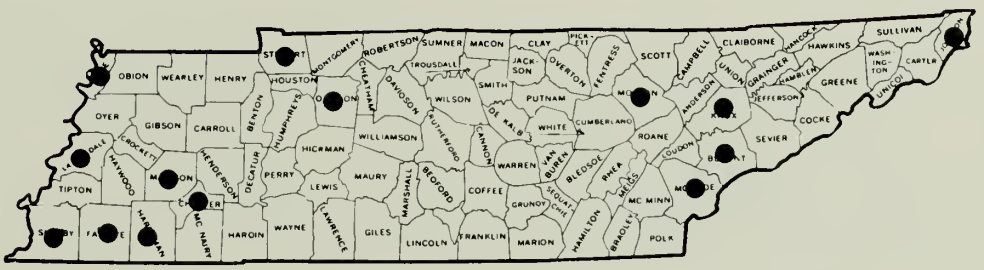

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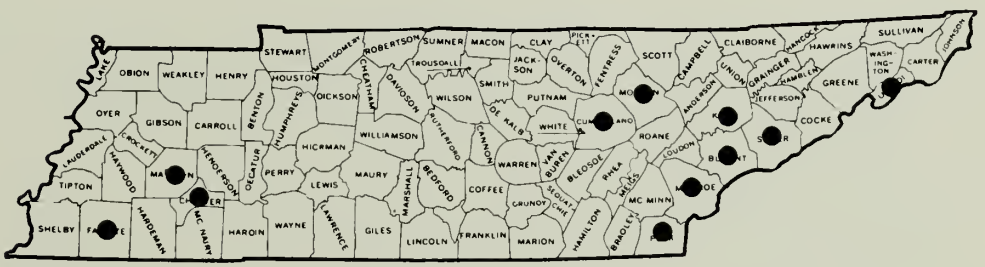

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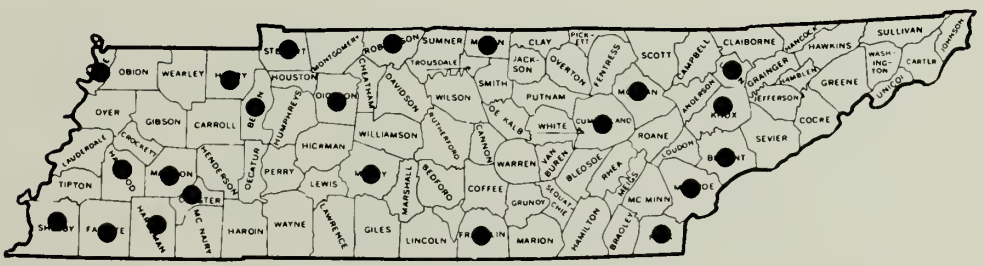

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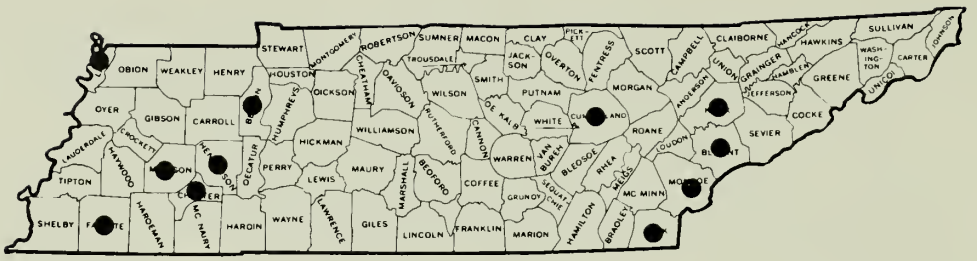

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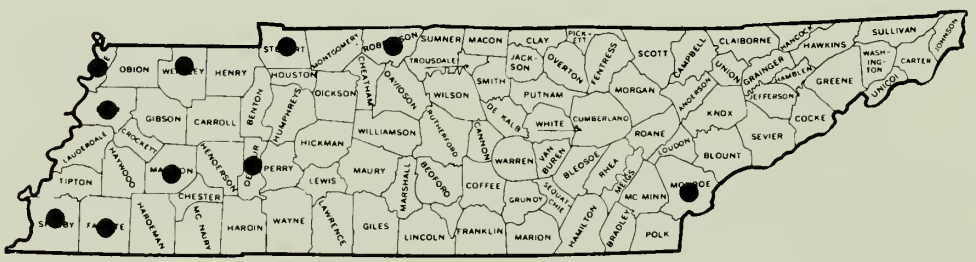

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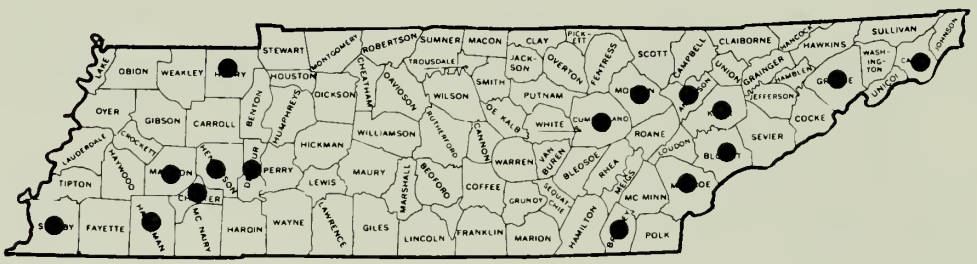

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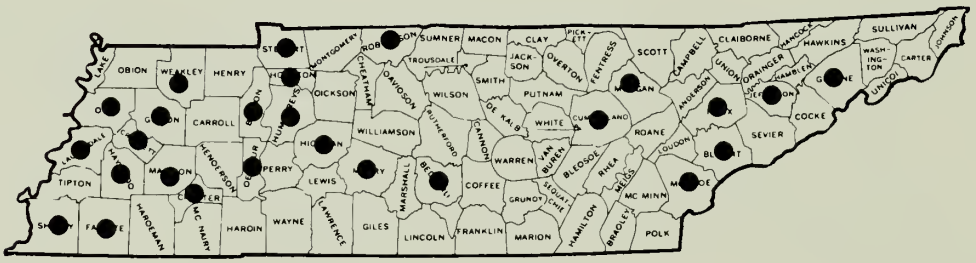

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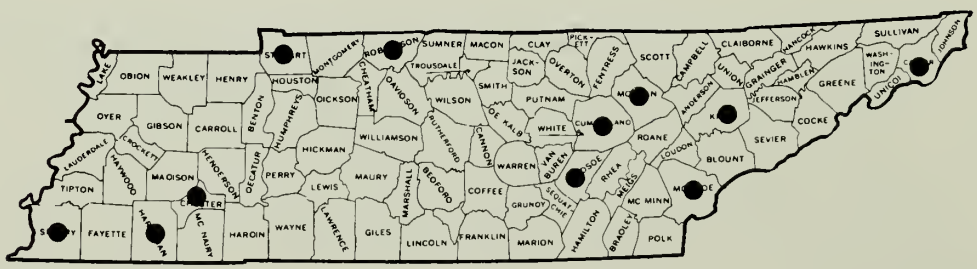

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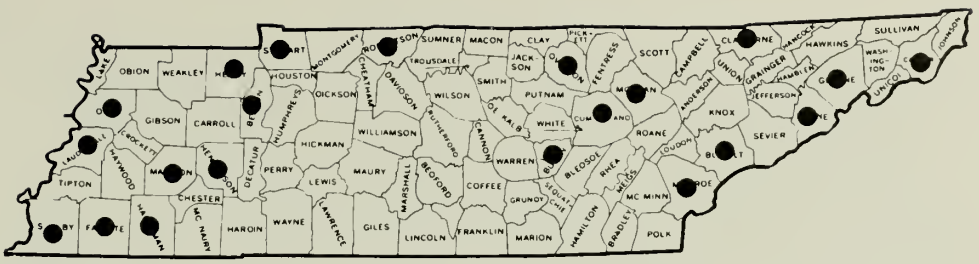

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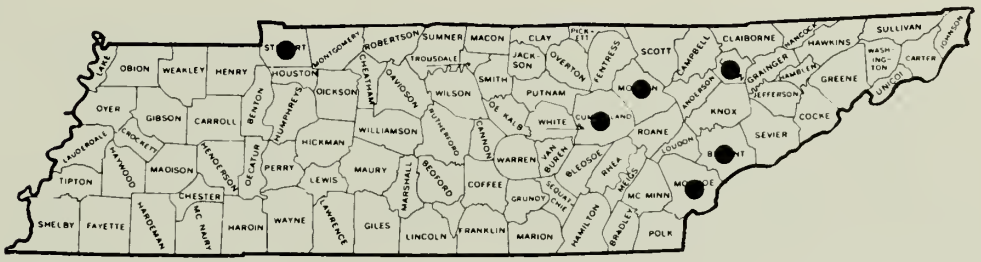

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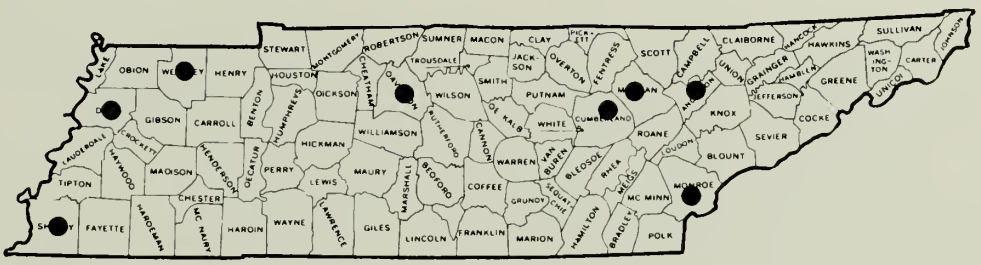

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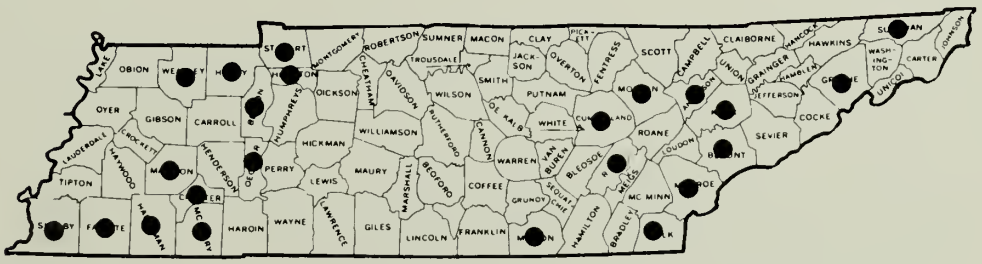

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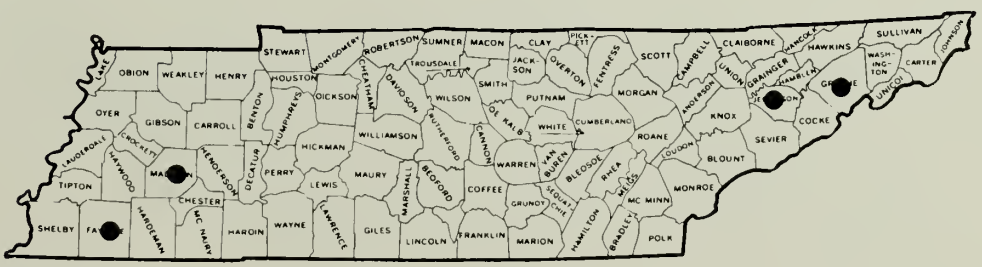

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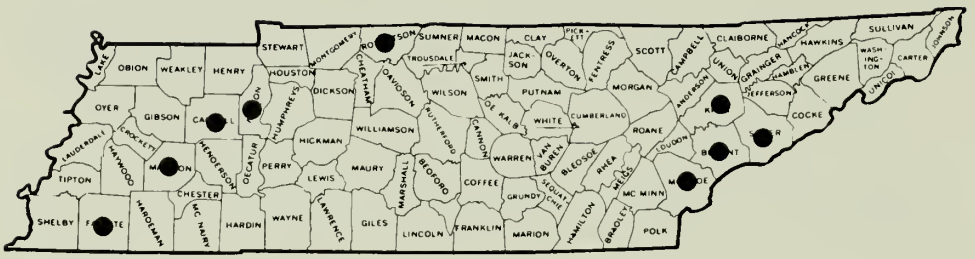

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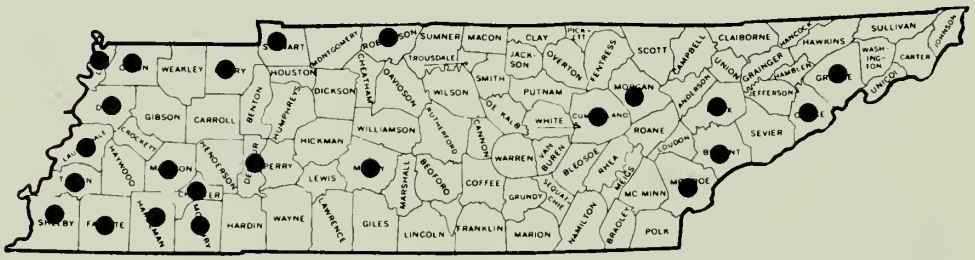

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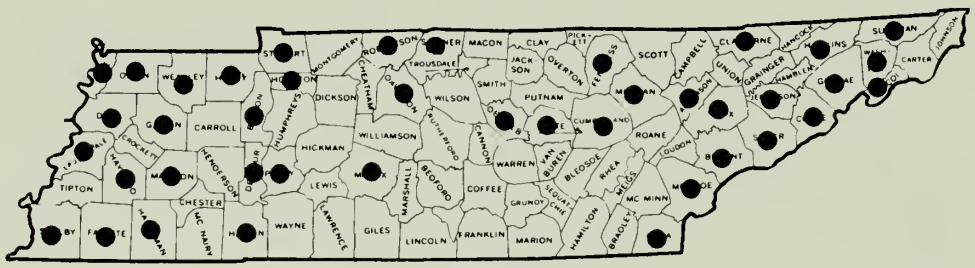

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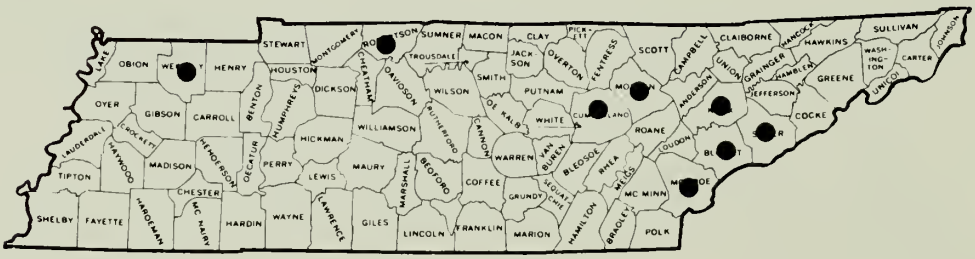

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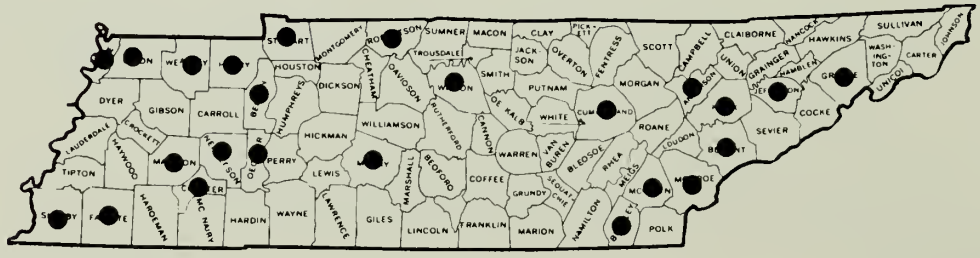

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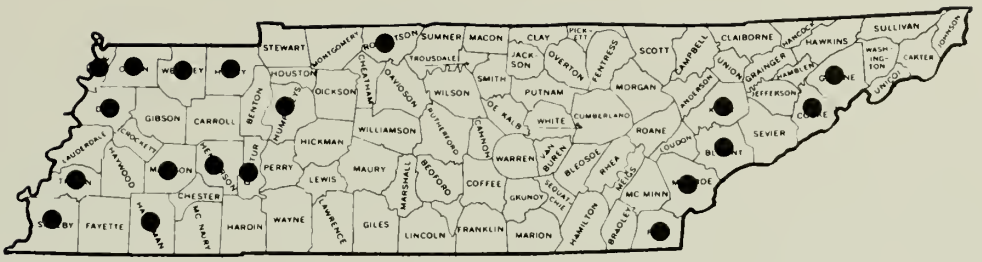

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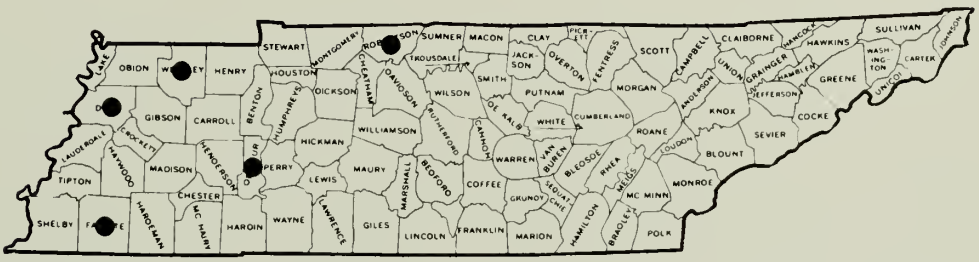

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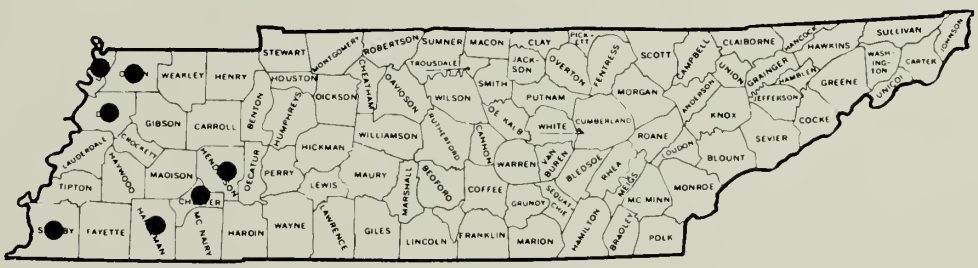
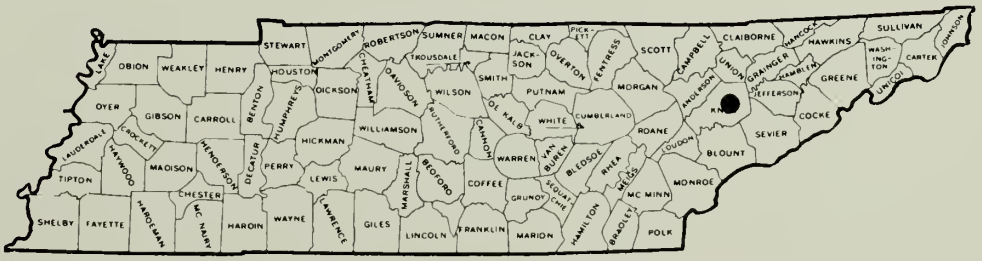


Tabanus wilsoni

Genus WHITNEYOMYIA Bequaert



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